Chapter 8  Electrical and Mechanical

8-1  General

The National Bridge Inspection Standards (NBIS)/National Tunnel Inspection Standards (NTIS), 23 CFR 650, requires that complex bridges and tunnels have specialized inspection procedures, and additional inspector training. These structures have numerous mechanical and electrical systems requiring inspection, troubleshooting, repair, and rehabilitation. This chapter serves as a guideline to illustrate inspection and reporting procedure as followed by the Complex Bridge and Tunnel section of the Bridge Preservation Office.

8-1.1  References

Inspection staff may refer to the following:

- AASHTO LRFD Movable Highway Bridge Design Specifications 2010
- AASHTO Movable Bridge Inspection, Evaluation, and Maintenance Manual 2017
- AASHTO Standard Specifications for Movable Highway Bridges, 1988
- FHWA Bridge Inspector’s Manual for Movable Bridges IP 77-10
- Emergency Operations Manual M 54-11
- Blue Ribbon Commission, Resolution No. 398
- FHWA Specifications for the National Tunnel Inventory 2015

8-1.2  Definitions

Some definitions for use with this chapter are as follows:

Complex Bridge – Complex bridges are defined in the NBIS as movable, suspension, cable stayed, and other bridges with unusual characteristics.

Complex bridges in Washington are referred to as “Special Feature” bridges where discussed in other chapters of this manual.

Complex Tunnel – Complex tunnels are defined in this manual as tunnels characterized by advanced or unique structural elements or functional systems.

National Bridge Inspection Standards (NBIS) – Title 23 Code of Federal Regulations 650 Part C defines the NBIS regulations, and establishes requirements for inspection procedures, frequency of inspections, qualifications of personnel, inspection reports, and preparation and maintenance of a state bridge inventory. The NBIS apply to all structures defined as bridges located on all public roads.
National Tunnel Inspection Standards (NTIS) – Title 23 Code of Federal Regulations 650 Subpart E defines the NTIS regulations, and establishes requirements for inspection procedures, frequency of inspections, qualifications of personnel, inspection reports, and preparation and maintenance of a state tunnel inventory. The NTIS apply to all structures defined as highway tunnels located on all public roads.

See Section 1-1.1 for additional definitions used in this manual.

8-2 Description of Complex Bridges and Tunnels

In accordance with the description of the Bridge Inspection Organization offered in Section 1-2, a bridge inspection program/tunnel inspection program as required by the NBIS and NTIS has been constructed to ensure safe and reliable operation of electrical/mechanical systems present on the bridges and tunnels listed in Appendix 8-E.

The Complex Bridge and Tunnel section is staffed by individuals, specialized in electrical or mechanical engineering, who have defined roles and responsibilities. Their roles and qualifications are as follows:

8-2.1 Delegated Program Manager (DPM)

A delegated program manager assumes some functions for the statewide program manager for the selected subset of structures under their direct control. To qualify as a delegated program manager, the individual must meet, at a minimum, the requirements as follows:

1. The individual in charge of the organizational unit that has been delegated the responsibilities for bridge inspection, reporting, and inventory shall possess the following minimum qualifications:
   a. Be a registered professional engineer in the State of Washington; or
   b. Have a minimum of 10 years' experience in complex bridge or tunnel inspection assignments in a responsible capacity.

Note: Although DPMs perform functions for the bridge inspection organization, overall responsibility for NBIS compliance still resides with the Statewide Program Manager.

8-2.2 Electrical/Mechanical Complex Bridge Lead Inspector (CBLI)

A CBLI is in charge of inspections and is responsible for planning, preparing, performing the field inspection of bridges/tunnels, and reporting observations/findings. The CBLI also makes repair recommendations and is responsible for initiating the critical damage procedures including full bridge or tunnel closure if deemed necessary. To qualify as a CBLI, the individual must meet, at a minimum, the requirements as follows:

(a) An individual in charge of an inspection team shall possess the following minimum qualifications:
   (1) Be a registered professional engineer in the State of Washington.
   (2) Have a minimum of 4 years' experience in complex bridge or tunnel inspection.
A continued certification of complex bridge inspection personnel has been developed in order to ensure that all program managers and CBLIs are kept up to date with the latest practices and technology in the areas of complex bridge and tunnel inspections. The continued certification of complex bridge inspection personnel is detailed in Appendix 8-D.

8-3 **Inspections**

Several different types of inspections are in place to adhere to the requirements of the NBIS and NTIS. This section identifies and describes the inspection types and reporting procedures used for mechanical and electrical inspections by the Bridge Preservation Office (BPO).

8-3.1 **Routine Inspections**

Regularly scheduled comprehensive safety and operational reliability inspections encompassing all mechanical/electrical elements of the structures listed in Appendix 8-E. Routine inspections are performed by a licensed professional engineer to evaluate safety as well as whether the electrical and mechanical systems are performing as designed, identify any changes from initial or previously recorded conditions, and ensure that electrical and mechanical components of structures pertaining to the Complex Bridge and Tunnels section continue to satisfy present service requirements.

1. **Frequency** – Routine electrical and mechanical inspections are conducted at a maximum of every 24 months as required by NBIS, Section §650.311 and NTIS, Section §650.511. Every complex bridge is inspected annually as suggested by AASHTO Movable Bridge Inspection, Evaluation, and Maintenance Manual Chapter 2.3 and required by the Transportation Structures Preservation Manual, Bridge Inventory and Inspection Rules.

2. **Inspecting Methodology** – Critical electrical and mechanical components are visually and operationally inspected. Non-destructive testing methods adhering to guidelines established by the AASHTO Movable Bridge Inspection, Evaluation, and Maintenance Manual Chapter 2, are used in evaluation of bridge components as well. Following these procedures throughout routine inspections helps ensure the safety and operational reliability of the mechanical and electrical systems by providing a thorough and comprehensive inspection.

3. **Inspection Report** – A routine inspection report (RIR) shall be prepared at the completion of each routine inspection to record the inspection findings, provide a narrative description of conditions at the site, and note any changes in the coding information. The CBLI shall record and submit the findings of the routine inspection into BridgeWorks as follows:

   a. At the conclusion of the routine inspection, confirm the Numerical Rating Condition (NRC), Appendix 8-C, coding for the various elements and make any changes necessary. Complete the narrative portion corresponding to any condition rating change describing the existing condition of its respective element. For tunnels, the FHWA Specifications for the National Tunnel Inventory is used as a guideline for rating tunnel specific elements.
b. Enter onto the inspection report: CBLI initials, CBLI identification number, date of inspection, total number of crew hours at the site, average bridge openings per month since last inspection, average marine traffic bridge openings per month since last inspection, average maintenance bridge openings per month since last inspection, and the number of inspection bridge openings.

c. Prepare a list of elements in need of repair and recommend the type of repair that should be done. A photo of repair areas should be taken with each type of recommended repair. Assign each repair a priority level. Text describing each repair should appear in the relevant element description. Deficiency photos are to be referenced in the column alongside the element description as well as the repair.

8-3.2 Blue Ribbon Inspections

Shall be unannounced random inspections intended to assess the reliability of the mechanical and electrical systems, identify needed preventative maintenance activities and develop the scope of required rehabilitation projects on the floating bridges. Blue ribbon inspections and the corresponding reports are completed by consultants considered to be experts in their field, managed by CBLIs, in accordance with Resolution No. 398. When blue ribbon electrical and mechanical inspections are performed, they are used in conjunction with the routine inspection for that structure.

1. Frequency – Due to permissions granted by the Bridge and Structures Engineer in 1994, blue ribbon inspections shall be conducted unannounced at least once every two years. This augmentation to the original annual inspection schedule recommended by Resolution No. 398 is provided in the memo in Appendix 8-A.

2. Inspection Methodology – Blue ribbon inspections consist of visual and operational inspection of the electrical and mechanical systems. Disassembly of electrical and mechanical components for closer inspection is also conducted throughout these inspections to gather a higher level of detail than is typical in the routine inspections. Non-destructive testing methods adhering to guidelines established by the AASHTO Movable Bridge Inspection, Evaluation, and Maintenance Manual Chapter 2, are used in evaluation of bridge components as well. Following these procedures throughout blue ribbon inspections helps ensure the safety and operational reliability of the mechanical and electrical systems by providing a thorough and comprehensive inspection.

3. Reporting – After completion of a blue ribbon inspection a RIR is to be entered into BridgeWorks in the same fashion as outlined in Section 8-3.1.3. In addition to this RIR another inspection report is to be generated by a consulting engineer. Consultant reports are detailed reports to be formatted as dictated by the document provided in Appendix 8-B. These reports include identified deficiencies, recommended actions to correct deficiencies, and cost estimates to complete recommended rehabilitation items. The DPM will coordinate the implementation of the recommended repairs and rehabilitation items with the Region maintenance staff.
8-3.3  **In-Depth Inspection**

Shall be a close-up inspection of one, several, or all electrical and mechanical elements to identify any deficiencies not readily detectable using routine inspection procedures. The results of these inspections are used to assess the reliability of mechanical and electrical systems, identify needed preventative maintenance activities, review and correct as-built schematics, review and correct OIM manuals, and develop the scope of required rehabilitation projects. In-depth electrical and mechanical inspections are used in conjunction with the routine inspection. Consultants, specialized in the specific field of interest, are used in conducting these inspections due to constant change in demand of disciplines, equipment, and vendors needed to accomplish the various in-depth inspections. Consulting engineers are managed by CBLIs in the same manner as those used in blue ribbon inspections.

1. **Frequency** – An in-depth inspection shall be performed in conjunction with a routine inspection every six years in accordance with the AASHTO *Movable Bridge Inspection, Evaluation, and Maintenance Manual* Chapter 2 Section 2.2.3. An in-depth inspection may also be performed as a follow-up inspection to a routine or blue ribbon inspection to better identify any deficiencies found. The first inspection on a new or rehabilitated structure shall be an in-depth inspection in order to establish a detailed baseline for the structure file.

2. **Inspection Methodology** – In-depth inspections consist of visual and operational inspections of the electrical and mechanical systems. Extensive disassembly of electrical and mechanical components for closer inspection is conducted throughout these inspections to gather a higher level of detail than is typical in blue ribbon and routine inspections. Non-destructive testing methods adhering to guidelines established by the AASHTO *Movable Bridge Inspection, Evaluation, and Maintenance Manual* Chapter 2, are used in evaluation of bridge components as well. Following these procedures throughout in-depth inspections helps ensure the safety and operational reliability of the mechanical and electrical systems by providing a thorough and comprehensive inspection.

3. **Reporting** – After completion of an in-depth inspection an RIR is to be entered into BridgeWorks in the same fashion as outlined in Section 8-3.1.3. In addition to this RIR another inspection report is to be generated by a consulting engineer. Consultant reports are detailed reports to be formatted as dictated by the document provided in Appendix 8-B and 8-G. These reports include identified deficiencies, recommended actions to correct deficiencies, and cost estimates to complete recommended rehabilitation items. The DPM will coordinate the implementation of the recommended repairs and rehabilitation items with the Region maintenance staff.

4. **Specialized Inspections** – Occasionally certain components/systems have their own specialized inspections carried out separately. Examples of components/systems that may require special inspections are trunnion bearings, counterweight ropes, and cathodic protection. Each of these inspections is functionally an in-depth inspection, pertaining only to that component or system, which are conducted and reported as such. This practice is suggested by AASHTO *Movable Bridge Inspection, Evaluation, and Maintenance Manual* Chapter 2 Section 2.2.4.
8-4 Complex Bridge and Tunnel QC/QA Program

The CBLIs review 100% of inspection reports under their responsibility prior to release. The majority of inspections involving the Complex Bridge and Tunnel section only concern one inspection engineer of each discipline. If multiple CBLIs of the same discipline participated in an inspection then that report will be reviewed by both engineers prior to submittal to the DPM.

An effort shall be made to rotate which CBLIs conduct routine inspections on each structure on an annual basis to add variation to the Complex Bridge and Tunnel section's internal QC program.

The DPM reviews 100% of all Complex Bridge and Tunnel reports under his area of responsibility prior to release.

The office review of reports will consist of validation for accuracy and consistency of the following:

- **Inspection Type** – The appropriate inspection types are identified.
- **Inspection Date** – Ensure that bridges are inspected on time.
- **Inspection Frequency** – Verify that inspection frequency is based on condition or policy (i.e., 12 month frequency criteria).
- **Inspection Hours** – Verify that the correct inspection hours are reported based on history of previous report hours, structure type and condition.
- **Organization of Report** – Verify that the report is organized, understandable, uses correct photo and file references that follow office policy.
- **Inspection Resources** – Verify that the appropriate resources needed for safety, access, and adequate inspection are being used.
- **NRC Codes** – Verify that the Numerical Rating Condition codes are supported by inspection report content. Coding information available in Appendix 8-C.
- **Elements** – Verify that the elements are complete and accurate.
- **Repair Recommendations and Priorities** – Verify that appropriate repairs and repair priorities are recommended based on inspection report content.
- **Follow-Up Actions on Significant/Critical Findings** – Ensure deficiencies that require immediate action have had the proper parties notified and are being monitored and/or followed up on.

Utilizing consultants on blue ribbon and in-depth inspections serves to act as QA for the Complex Bridge and Tunnel section. An effort is made to rotate which consultant conducts each blue ribbon or in-depth inspection. This process helps to ensure delivery of a comprehensive and high quality inspection program.
8-5 Tunnel Inspection Duties

Routine inspections of the electrical and mechanical systems present in highway tunnels are to be conducted at a maximum of 24 month intervals. Routine inspections result in an inspection report created and submitted through BridgeWorks. In-depth inspections result in detailed consultant reports that are reviewed by CBLIs in addition to a standard RIR. In-depth inspections of the mechanical and electrical systems are to be conducted at least once every six years on complex tunnels. Maintenance and inspection guidelines for mechanical and electrical systems present in tunnels are outlined in the FHWA Tunnel Operations, Maintenance, Inspection and Evaluation (TOMIE) Manual.

8-6 Complex Bridge and Tunnel Records

8-6.1 Operation, Inspection and Maintenance Manuals

Operation, Inspection, and Maintenance (OIM) Manuals developed by the Bridge Preservation Office as mandated by Transportation Structures Preservation Manual M 23-11 exist for nearly all complex bridges in WSDOT’s inventory. OIM manuals contain important information relevant to their corresponding structure including but not limited to specific operational procedures, emergency procedures, recommended maintenance scheduling and procedure, as well as inspection procedures. OIM manuals are invaluable for planning of inspection and maintenance activities. They are a source of information recommended by AASHTO Movable Bridge for Inspection, Evaluations, and Maintenance Manual Section 2.6.1.1 and AASHTO LRFD Movable Highway Bridge Design Specifications Section 1.7.1.1. Critical information needs mentioned in FHWA Tunnel Operations, Maintenance, Inspection and Evaluation (TOMIE) Manual Sections 2.4 and 3.3 are standard in an OIM manual.

Both of these manuals as well as any as-builts must be periodically updated as structures are rehabilitated and the information contained within them becomes obsolete. Region(s) input is invaluable in the process of creating OIM manuals and correctly identifying operating procedures for each structure. OIM Manuals are developed partially using the Operations and Maintenance (O&M) manuals provided to WSDOT as a result of Standard Specifications Section 1-06.5. O&M manuals consist of catalog cuts or shop drawings of each piece of equipment found on its corresponding structure. Contract documents, special provisions, and as-builts are also used in the process of generating the OIM manual.

Master copies of each OIM manual are retained by the BPO and the regions are provided with copies of every manual relevant to their bridges. A complete list of OIM manuals developed by the BPO is included in Appendix 8-F.
8-6.2 Structure Files

Every complex bridge and tunnel has its own structure file maintained in accordance with the standards set in Chapter 2 of this manual to satisfy the FHWA. The physical location of structure file documents is indicated in Appendix 2-A “Bridge Preservation Floor Plan.” A more detailed explanation of the legend is as follows:

- “B- Movable Bridge Files” refers to project files, signed copies of every bridge inspection report, signed copies of every tunnel inspection report, contract documents, microfilm cards and antiquated pictures from old inspections.
- “F-Letter Files” refers to the movable bridge letter files as well as reports generated by consultants. These reports are the original stamped and signed copies that come as a result of a Blue Ribbon inspection or an In-Depth inspection.

The current Routine and In-Depth inspection databases containing inspection dates and intervals for scheduling purposes are available to view on the Corporate drive. These files are only editable by members of the Complex Bridge and Tunnel section. These databases are available along the following file path on the Corporate drive: \Data\Bridge\Movable. Folders labeled “Routines” and “In-Depth Database” contain the relevant files.

8-7 Bridge Damage/Emergency Responsibilities

As dictated in the WSDOT Emergency Operations Plan M 54-11 BPO personnel are provided with emergency responder training. The BPO employs multiple mechanical and electrical engineers with offset schedules such that in the event of an emergency situation involving an electrical or mechanical component failure, personnel will be available to provide technical assistance to the Region(s). Should an emergency situation occur the Region(s) are to contact the BPO at which point technical assistance will be dispatched. After any emergency response situation the CBLI onsite for the incident shall prepare a report to be distributed amongst the BPO and the Region(s) via email. The BPO can always be reached via the emergency response phone at 360-480-4500.

8-8 Plans, Specifications and Estimates

The BPO assists the region with preparation of Plans, Specifications & Estimates documentation for the purpose of special inspections, requiring consultants, as well as rehabilitation activities. In the event electrical and mechanical components need to be acquired through the bidding process, the BPO provides assistance to the region with preparation of the proper documentation. During construction of repairs or rehabilitation of structures the BPO is available to assist the Region(s) and the Project Engineer Office as needed.
Appendices

Appendix 8-A  BPO Memo for Blue Ribbon Inspection Schedule Alteration
Appendix 8-B  Guideline for Writing Bridge Electrical and Mechanical Inspection Reports
Appendix 8-C  Numerical Rating Condition Description
Appendix 8-D  Continued Certification of Bridge Inspection Personnel
Appendix 8-E  Complex Bridge and Tunnel Inspection List
Appendix 8-F  Operations, Inspection, and Maintenance Manual List
Appendix 8-G  Guideline for Writing Tunnel Electrical and Mechanical Inspection Reports
The random inspection shall include an element of "surprise" and an element of "independence" to and from the regular maintenance folks and their activities. Are we accomplishing this?

Please include me in the random inspections that are coming up. Thanks.
Date: May 10, 1994

From: O. R. George
Phone: 753-4739

Subject: Proposed Schedule For Floating Bridge Random Inspections

To: M. Myint Lwin
Bridge & Structures - 7340

Random inspections of the four floating bridges are conducted by our office as outlined in the attached June 8, 1993 memorandum from A. H. Walley to S. A. Moon. We propose to delay the mechanical and electrical inspections on the Evergreen Point Bridge (520/8) until 1995 due to the major mechanical and electrical renovations taking place this summer. Inspections by our office during the construction phase would be redundant since the designer, Sverdrup Corporation will be assisting with construction services.

We also propose to conduct the first electrical random inspection on the Lacey V. Murrow Bridge (90/25S) in 1995. This first inspection will be within 2 years of opening the bridge to traffic and will meet the requirements of the June 8, 1993 memorandum. It was determined after the 1992 mechanical inspection of the Third Lake Bridge (90/25N) that mechanical inspections on both of the I-90 floating bridges are not needed due to their lack of mechanical components.

When in-depth mechanical/electrical inspections performed by consultants coincide with the random mechanical/electrical inspections, we will use the in-depth inspections in place of the random inspections. This occurs on the Hood Canal Bridge in 1994 and is denoted on the schedule by an asterisk.

With your approval, we would like to adopt the inspection schedule shown below which allows us to conduct 1 mechanical and 2 electrical inspections per year, rather than 2 mechanical and 4 electrical inspections every other year.
M. Myint Lwin  
May 10, 1994  
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<table>
<thead>
<tr>
<th>Bridge No.</th>
<th>Water-Tightness</th>
<th>Electrical</th>
<th>Mechanical</th>
</tr>
</thead>
<tbody>
<tr>
<td>90/25S</td>
<td>Annually</td>
<td>1995, 1997, ...</td>
<td>NA**</td>
</tr>
<tr>
<td>90/25N</td>
<td>Annually</td>
<td>1994, 1996, ...</td>
<td>NA**</td>
</tr>
<tr>
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<td>Annually</td>
<td>1994*, 1996, ...</td>
<td>1994*, 1996, ...</td>
</tr>
<tr>
<td>520/8</td>
<td>Annually</td>
<td>1995, 1997, ...</td>
<td>1995, 1997, ...</td>
</tr>
</tbody>
</table>

* In-depth electrical/mechanical inspections by consultants

** Random mechanical inspections not needed, as determined after the 1992 random mechanical inspection on 90/25S.

* Shall include inspection/testing of sensors piping system and pumps.

ORG: jj
MPP/DLS
Attachment

Approval: [Signature]  
Date: 5-28-94

M. MYINT LWIN, P.E.  
Bridge and Structures Engineer
Memorandum

Date: June 8, 1993
From: A. H. Wall  
J. F. Conrad  
Subject: Floating Bridge Random Inspections
Thru: E. R. Burch  
J. R. Buss
To: S. A. Moon

As directed by the Transportation Commission, random inspections have been conducted on the three state floating bridges. Based on our office's evaluation of the initial inspections, we request your approval of the following proposals on the process to be used in the future:

1. Responsibility for planning and conducting the random inspections should be delegated to the Bridge Office, and clearly defined in Directive D23-11.

2. A report on findings on each inspection should be prepared by the Bridge Office and sent to the Chief Maintenance Engineer for further transmittals to the districts.

3. Annual random inspections should be conducted to verify water-tightness of the bridge pontoons.

Random inspections focusing on reliability of mechanical and electrical systems of the bridges should be conducted at two year intervals.

The following background is provided to assist in your consideration of the above proposals:

The Report issued on May 2, 1991 by the Blue Ribbon Panel investigating the sinking of the Lacey V. Murrow Bridge included a recommendation for "Independent Random Inspections" of the state's floating bridges. These inspections were to be in addition to the scheduled major inspections, and were to be conducted by people not responsible for bridge maintenance. Emphasis of the inspections was to be "placed on the water-tightness of the bridge and on the reliability of electrical and mechanical systems."
Transportation Commission Resolution 398 directed the department to "carefully review, analyze and, if feasible incorporate certain recommendations of the Blue Ribbon Panel". The Resolution’s "implementing action document" directs us to address random inspections as follows:

"The Department will hire a consultant or utilize an independent division internal to the Department to provide random inspections on the floating bridges. These inspections are to occur and be announced at least once a year for each bridge and will be a thorough review of the watertightness of the floating pontoons. An inspection of the mechanical and electrical component of each bridge. A detailed report will be required."

Copies of pertinent sections of the Blue Ribbon Panel Report and Resolution 398 are attached.

An initial random inspection was conducted on the Hood Canal, Evergreen Point and 3rd Lake Floating Bridges in August and September of 1992. The inspection team consisted of members from the Bridge and Structures and Marine Transportation Offices and from the office of the State’s mechanical and electrical consultant, the Sverdrup Corporation. Reports on inspection findings were prepared by the Bridge Office and provided to the districts through the HQ Maintenance Office. Inspection recommendations are now being implemented or considered for implementation by the districts.

A post inspection review of the random inspection process by our offices led to the recommendations in this letter. Responsibilities for these inspections need to be clearly defined in a Department Directive. Also, although a one year interval for random inspection of pontoon watertightness appears to be appropriate, a longer interval is needed between random inspections of the electrical and mechanical systems. The longer interval is needed to provide sufficient time to cost-effectively address any problems identified on these complex systems.

AHW/JFC: sf
OG
Attachments

Approval: [Signature]
Deputy Secretary of Transportation
Date: 6-22-93
GUIDELINE FOR WRITING BRIDGE ELECTRICAL AND MECHANICAL INSPECTION REPORTS FOR WSDOT

General - Format and fonts used in the electrical and mechanical inspection reports must be the same. Single side print. Condition descriptions shall be consistent with the verbiage in the Condensed Mech/Elect Rating Summary in Appendix B.

See page 4 of 9 for a sample cover page.

The first submittal received by WSDOT shall be an unsigned final report. This submittal shall consist of 2 copies of each report.

The title of the report and the bridge name and bridge number will be indicated exactly as spelled out in the scope of work for the inspection.

A photograph of the general outline of the bridge will appear on the cover of the reports.

The Consultants Company name will appear under the photograph.

The PE Seal shall be placed below the photograph on the first submittal but not signed. When the final submittal is ready for the PE Seal it shall be placed on the original report and signed by the Consultant. Color copies will then be made of the original report.

The Table of Contents page shall be page number i. Each page of the report will be numbered sequentially and will agree with the page numbers listed in the Table of Contents. Font size shall be No. 12.

See page 5 of 9 for a sample Table of Contents.

The footers for each report page and appendices shall have the bridge name and number on two lines on the bottom left, the page number in the bottom center and the type of inspection and month and year on two lines on the bottom right. The font shall be No. 10.

The font for the report titles and text shall be No. 12. Heading shall be capitalized and bold.

The report shall include the following sections in the order listed:

The Executive Summary should be brief but give a general assessment of the condition of the bridge systems, major conclusions and a summary of any pertinent recommendations.
The Purpose and Scope of Inspection should state that the purpose of the inspection is to determine the condition of the bridge equipment and identify any deficiencies. The dates of the inspection and the Consultants Company name should also be indicated. Reference shall be made to the Scope of Work provided by WSDOT in the inspection request for proposal and it shall be attached to the report in Appendix A.

See page 6 of 9 for a sample of the Executive Summary, the Purpose and the Scope of Work.

Any deviations from the Scope of Work should be identified with an explanation of why the deviations occurred.

Inspection Methodology should briefly describe the type of inspections, tests or measurements performed.

A general description of the bridge is not required. We know where the bridge is, what river it crosses and how it operates.

Inspection Findings shall identify the condition of the systems in the order that they are listed in the Scope of Work. All deficiencies shall be identified and reference shall be made to its attached photograph. The photographs shall be the last Appendix in the report except when additional data such as oil sample analysis or other sub-consultant reports are attached. The photos shall be referenced in the body of the report as follows: (See Photo ___ in Appendix __). Data such as motor currents, insulation resistance, gear tooth measurements, etc. shall be tabulated and included in the Appendices. The tabulated data shall be referenced in the body of the report as follows: (See Table ____ in Appendix ___).

Conclusions shall summarize major findings and condition of the structure. The conclusion is intended to be brief. Under each of these categories they shall be listed in the order in which they appear in the Scope of Work.

Recommendations shall include Emergency Repairs, Maintenance Repairs or Rehabilitation Recommendations. Emergency Repair recommendations which are not addressed during the inspection shall be made in writing within 48 hours of the finding from the Consultant to the Bridge Preservation Engineer. Recommendations for Maintenance Repairs must be within the capabilities of the available maintenance forces. Rehabilitation recommendations should be made for conditions which will provide 20+ years of extended service. See page 7 of 9 for an example Recommendations section.

Cost estimates shall be listed for each rehabilitation recommendation in the order that the system appears in the Scope of Work. (Service Entrance; Power Distribution; Motors and Brakes; Control System; Wire and Conduit; etc.) Do not say Electrical and Mechanical Rehabilitation and give a lump sum figure. Beneath the cost estimate a note shall indicate that cost estimates are for material and
installation labor (bridge items only). They do not include cost for design engineering, maintenance, traffic control, construction management or administration. See page 7 of 9 for an example cost estimate.

Appendices shall be made attached in the following order:

Appendix A – Scope of Work

Appendix B – Condensed Mech/Elect Rating Summary
   B1 Numerical Rating Condition Description (WSDOT provided with Scope of Work)
   B2 Condensed Mech/Elect Rating Summary
   C, D, etc – tabulated data, schematics, tables of measurements etc.

The last Appendix should be photographs unless there are Co-Consultant documents like oil analysis in which case the photographs are the next to last and the Co-Consultant data is last. There shall be two photographs on each page.

Appendices shall have a cover page with a Table of Contents.

See page 8 of 9 for a sample Appendix Table of Contents
Appendices sheets shall have the same footer as the report but the page number will be prefaced with the letter of the Appendix

Data sheets and measurements sheets shall be arranged in the order that the subject appears in the Scope of Work.

See page 9 of 9 for a sample photograph page.

All reports are to be comb bound with clear plastic front covers and black plastic rear covers. The unsigned final report submittal shall consist of 2 copies of each report. The final submittal shall consist of one bound final report with original photographs which shall be stamped and signed by an Engineer of the appropriate discipline licensed in the State of Washington and six color copies of the report. An electronic copy of the final report in PDF format and an electronic copy of all photographs in jpeg format along with photo logs shall be submitted with the signed final reports on a credit card size USB drive.
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<th>i</th>
<th>Type of Inspection</th>
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<tbody>
<tr>
<td>Bridge No.</td>
<td>i</td>
<td>Month, Year</td>
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5     wirgrev12
EXECUTIVE SUMMARY

This report documents the condition of the Bridge Name and Bridge Number, electrical (or mechanical) systems. Overall, the bridge operated in an acceptable manner during the inspection. There were no emergency repairs required at this time. Items which required maintenance have been identified in the recommendations. Items requiring rehabilitation include the following: (Do not just copy the repair list or the rehabilitation recommendation list. Write a summary.)

PURPOSE AND SCOPE OF INSPECTION

The purpose of this report is to document the condition of the Bridge Name and Number on which an In-Depth Electrical (or Mechanical) inspection was performed on (Date). The Scope of Work for this inspection is attached as Appendix 1.
RECOMMENDATIONS

EMERGENCY REPAIRS
There were no emergency repairs.

MAINTENANCE REPAIRS

Power Distribution
1. Sample repair number one.
2. Sample repair number two.

Control System
3. Sample repair number three.

Wire, Conduit and Junction Boxes
4. Sample repair number four.
5. Sample repair number five.
6. Sample repair number six.

Traffic Control
7. Sample repair number seven.

REHABILITATION RECOMMENDATIONS
1. Sample recommendation number one.

COST ESTIMATE
1. Sample recommendation number one. $100,000

The provided cost estimate is for material and installation labor (bridge items only). This cost does not include design engineering, maintenance, traffic control, construction management or administration.

Name of Bridge
Bridge No.

8

Type of Inspection
Month, Year

7

wirgrev12
### APPENDIX D

### PHOTOGRAPHS

<table>
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<tr>
<th>Photo 1</th>
<th>Photo Title……………………………………………………</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Photo 2</td>
<td>Photo Title……………………………………………………</td>
<td>D1</td>
</tr>
<tr>
<td>Photo 3</td>
<td>Photo Title……………………………………………………</td>
<td>D1</td>
</tr>
<tr>
<td>Photo 4</td>
<td>Photo Title……………………………………………………</td>
<td>D2</td>
</tr>
<tr>
<td>Photo 5</td>
<td>Photo Title……………………………………………………</td>
<td>D3</td>
</tr>
</tbody>
</table>

Name of Bridge  
Bridge No.  
Di  
Type of Inspection  
Month, Year

8  
wirgrev12
Guideline for Writing Bridge Electrical and Mechanical Inspection Reports

Appendix 8-B

Photo 1  Control Desk

Photo 2  Broken conduit fitting on NE Thrustor Brake

Name of Bridge  D1  Type of Inspection
Bridge No.  9  Month, Year

wirgrev12
## Appendix 8-C  Numerical Rating Condition Description

<table>
<thead>
<tr>
<th>Rating Condition</th>
<th>Description of Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>FAILED CONDITION</td>
<td>Item not operational</td>
</tr>
<tr>
<td>POTENTIALLY HAZARDOUS</td>
<td>Deterioration or damage to span drive or stabilizing machinery which could cause moveable span to become imminently unsteady in any position. Malfunction or deterioration of electrical system which could cause loss of control of the moveable span. Deficiency in electrical system design, maintenance, or operational procedure which could cause loss of control of moving span. Inoperable vehicular traffic control device. Also, extreme case of defects listed under higher rating numbers. Bridge may not be opened to marine traffic. If problem is with stabilizing machinery in the closed position, temporary shoring or support may be necessary to permit safe vehicular traffic over the closed bridge at reduced speed or rating. However, if problem is with counterweights of vertical lift bridge stabilizing machinery, bridge may be closed to all traffic until shored or repaired.</td>
</tr>
<tr>
<td>VERY SERIOUS DETERIORATION</td>
<td>Deterioration or damage to machinery which will not cause imminent instability of a non-redundant span drive but reduces allowable load on span and may cause future instability if not corrected. Stabilizing machinery damaged, deteriorated, or improperly operated such that movable structure is not properly supported causing structure not to behave as designed and resulting in structural overstress and movements under vehicular traffic that severely affect quality. Severe misalignment of stabilizing machinery, resulting in overload of electrical system and consequent overstress of span drive machinery. Severe interference between moving span and fixed structure due to substructure movements. Deterioration of electrical control system such that many of the safety interlocks are normally by-passed, inconsistent control of moving span, and inoperable or missing traffic control devices. Operation of moveable span may be restricted in terms of opening angle, number of openings, and allowable wind velocity. If problem is with stabilizing machinery, shoring may be necessary to permit vehicular traffic.</td>
</tr>
<tr>
<td>SERIOUS DETERIORATION</td>
<td>Severe wear, deterioration or damage to span drive or stabilizing machinery due to overloading, inadequate maintenance, improper operation, or movement of the structure or substructure. Electrical system malfunctions and numerous safety interlocks are by-passed. Results are inconsistent, noisy, and unreliable operation of the movable span. Improper closure, affecting structural action and vehicular ride quality. Electrical system has archaic components for which replacements are no longer available and open bus panelboards that are considered unsafe for nowdays.</td>
</tr>
<tr>
<td>MODERATE DETERIORATION</td>
<td>Excessive wear, some damage and deterioration of span drive and stabilizing mechanical machinery. Repairs and replacement of some machinery components required. Bearings may need liner adjustment. Machinery may be misaligned due to shifting of structure and substructure but not enough to seriously overload span drive. Correctable by adjusting machinery component location using shims, etc. Replacement of corroded machinery fasteners required. Moving span under control but some indicating and safety devices may be inoperable and may be by-passed, and span limit switch may need adjustment.</td>
</tr>
<tr>
<td>MINOR DETERIORATION</td>
<td>None of the major mechanical machinery components are worn or damaged to the extent that replacement is now required. Some components of the span drive may need to be replaced, such as few-couplings gears, brake linings, etc. Span stabilizing machinery functioning except that wear may have caused excessive clearance in lock bar guides, etc. Shimming of lock bar guides, replacement of limit switches and adjustments necessary. Machinery needs cleaning, painting, lubrication and adjustment. Electrical system generally functioning as designed. Replacement of some relays, indicating devices and lights may be required. Traffic control devices need repair or maintenance.</td>
</tr>
<tr>
<td>ALMOST NEW CONDITION</td>
<td>No extensive repairs required. Machinery needs cleaning, painting, lubrication, and adjustment. Electrical systems functioning as designed; may need replacement of indicating lights and minor limit switch adjustment, cleaning of relay contacts and housekeeping in panelboard. Traffic control devices functioning but may need replacement of obstruction lights, object markers, painting of housings, lubrication and adjustment of limit switches.</td>
</tr>
<tr>
<td>NEW CONDITION</td>
<td>Virtually no repairs required. Mechanical machinery may need cleaning, touch-up painting and housekeeping. Electrical system and traffic devices functioning but may need replacement of bulbs and minor housekeeping.</td>
</tr>
<tr>
<td>NOT APPLICABLE</td>
<td>This device or equipment is not on the structure being inspected.</td>
</tr>
<tr>
<td>NOT INSPECTED</td>
<td>This device or equipment was not included in the inspection.</td>
</tr>
</tbody>
</table>
Appendix 8-D  Continued Certification of Complex Bridge Inspection Personnel

A continued certification of complex bridge and tunnel inspection personnel has been established to ensure that all program managers and inspectors are kept up to date with the latest practices and technology in the areas of bridge and tunnel inspections. This continued certification program requires that each Electrical/Mechanical Complex Bridge Lead Inspector (CBLI) and their Delegated Program Manager (DPM) must participate in the following during a 60 month period to maintain certification:

- 30 hours of bridge related continuing education courses and training including WSDOT sponsored bridge training, bridge conferences and other NHI bridge training courses as approved by the delegated program manager.

Continued Certification Course and Training List

The following is a list of courses that are examples of what would qualify in combination to acquire 30 hours of continuing education hours in the designated five-year period. It is the inspector’s responsibility to ensure that the information is given to their manager within the necessary timeframes to ensure continued certification.

- National Electric Code 16 hours
- Grounding and Bonding Training 16 hours
- NFPA 70E Arc Flash Electrical Safety 16 hours
- Programmable Logic Controller Training 24 hours
- AC/DC Motors and Drives Training 16 hours
- Cathodic Protection 40 hours
- National Fire Alarm and Signaling Code 24 hours
- Non-Destructive Testing Training 24 hours
- Hydraulics & System Troubleshooting 16 hours
- Principles of Bearings and Lubrication 16 hours
- Coupling and Shaft Alignment 16 hours
- Strain Gage Workshop 40 hours
- Pacific NW Bridge Maintenance Conference 16 hours
- Pacific NW Bridge Inspection Conference 16 hours
- Heavy Movable Structures Conference 16 hours
- Western Bridge Engineers’ Seminar 16 hours
- WSDOT/LTAP – Bridge Condition Inspection Training (BCIT) 72 hours
- NHI Bridge Inspection Refresher Training (BCIR) 16 hours
- NHI Tunnel Safety Inspection 16 hours
- NHI Tunnel Safety Inspection Refresher 16 hours
Appendix 8-E  Complex Bridge and Tunnel Inspection List

The following is a list of complex bridges and tunnels that require electrical and mechanical inspections in accordance with the NBIS and NTIS. The regularly scheduled inspections for each structure are listed along with their frequency. Special inspections in addition to those listed may be conducted if deemed necessary.

12/12N – Wishkah River Bridge
   Electrical
   Routine Inspection (12 months)  Routine Inspection (12 months)
   In-Depth Inspection (72 months)  In-Depth Inspection (72 months)

12/12S – Heron Street Bridge
   Electrical
   Routine Inspection (12 months)  Routine Inspection (12 months)
   In-Depth Inspection (72 months)  In-Depth Inspection (72 months)

12/915 – Snake River Clarkston
   Electrical
   Routine Inspection (12 months)  Routine Inspection (12 months)
   In-Depth Inspection (72 months)  In-Depth Inspection (72 months)
   Counterweight Rope Inspection (72 months)
   Trunnion Bearing Inspection (72 months)

16/110E – Tacoma Narrows
   Electrical
   Routine Inspection (12 months)  Routine Inspection (12 months)
   In-Depth Inspection (72 months)  In-Depth Inspection (72 months)

16/110W – Tacoma Narrows
   Electrical
   Routine Inspection (12 months)  Routine Inspection (12 months)
   In-Depth Inspection (72 months)  In-Depth Inspection (72 months)

90/25N – Homer M. Hadley
   Electrical
   Routine Inspection (12 months)
   Blue Ribbon Inspection (24 months)
   Blue Ribbon Cathodic Protection Inspection (24 months)
   In-Depth Inspection (72 months)
   In-Depth Cathodic Protection Inspection (72 months)
90/25S – Lacey V. Murrow
   Electrical
   Routine Inspection (12 months)
   Blue Ribbon Inspection (24 months)
   Blue Ribbon Cathodic Protection Inspection (24 months)
   In-Depth Inspection (72 months)
   In-Depth Cathodic Protection Inspection (72 months)

99/530E – Duwamish River Br
   Electrical
   Routine Inspection (12 months)
   In-Depth Inspection (72 months)
   Mechanical
   Routine Inspection (12 months)
   In-Depth Inspection (72 months)

99/530W – Duwamish River Br
   Electrical
   Routine Inspection (12 months)
   In-Depth Inspection (72 months)
   Trunnion Bearing Inspection (72 months)
   Mechanical
   Routine Inspection (12 months)
   In-Depth Inspection (72 months)

101/115 – Chehalis River Bridge
   Electrical
   Routine Inspection (12 months)
   In-Depth Inspection (72 months)
   Mechanical
   Routine Inspection (12 months)
   In-Depth Inspection (72 months)

101/125E – Hoquiam River - Riverside
   Electrical
   Routine Inspection (12 months)
   In-Depth Inspection (72 months)
   Mechanical
   Routine Inspection (12 months)
   In-Depth Inspection (72 months)
   Counterweight Rope Inspection (72 months)

101/125W – Hoquiam River - Simpson
   Electrical
   Routine Inspection (12 months)
   In-Depth Inspection (72 months)
   Mechanical
   Routine Inspection (12 months)
   In-Depth Inspection (72 months)

104/5.1 – Hood Canal-W.A. Bugge Bridge W
   Electrical
   Routine Inspection (12 months)
   Blue Ribbon Inspection (24 months)
   Blue Ribbon CP Inspection (24 months)
   In-Depth Inspection (72 months)
   In-Depth CP Inspection (72 months)
   Mechanical
   Routine Inspection (12 months)
   Blue Ribbon Inspection (24 months)
   In-Depth Inspection (72 months)
<table>
<thead>
<tr>
<th>Bridge Name</th>
<th>Inspection Types</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>104/5.2 – Hood Canal-W.A. Bugge Br E</td>
<td>Electrical Routine Inspection (12 months)</td>
<td>12 months</td>
</tr>
<tr>
<td></td>
<td>Mechanical Blue Ribbon Inspection (24 months)</td>
<td>24 months</td>
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<tr>
<td></td>
<td>Blue Ribbon CP Inspection (24 months)</td>
<td>24 months</td>
</tr>
<tr>
<td></td>
<td>In-Depth Inspection (72 months)</td>
<td>72 months</td>
</tr>
<tr>
<td></td>
<td>In-Depth CP Inspection (72 months)</td>
<td>72 months</td>
</tr>
<tr>
<td>513/12 – Montlake Bridge</td>
<td>Electrical Routine Inspection (12 months)</td>
<td>12 months</td>
</tr>
<tr>
<td></td>
<td>Mechanical In-Depth Inspection (72 months)</td>
<td>72 months</td>
</tr>
<tr>
<td>520/8 – Albert D. Rosellini Bridge</td>
<td>Electrical Routine Inspection (12 months)</td>
<td>12 months</td>
</tr>
<tr>
<td></td>
<td>Mechanical Blue Ribbon Inspection (24 months)</td>
<td>24 months</td>
</tr>
<tr>
<td></td>
<td>In-Depth Inspection (72 months)</td>
<td>72 months</td>
</tr>
<tr>
<td>529/10E – Snohomish River Bridge</td>
<td>Electrical Routine Inspection (12 months)</td>
<td>12 months</td>
</tr>
<tr>
<td></td>
<td>Mechanical In-Depth Inspection (72 months)</td>
<td>72 months</td>
</tr>
<tr>
<td></td>
<td>Counterweight Rope Inspection (72 months)</td>
<td></td>
</tr>
<tr>
<td>529/10W – Steamboat Slough</td>
<td>Electrical Routine Inspection (12 months)</td>
<td>12 months</td>
</tr>
<tr>
<td></td>
<td>Mechanical In-Depth Inspection (72 months)</td>
<td>72 months</td>
</tr>
<tr>
<td></td>
<td>Counterweight Rope Inspection (72 months)</td>
<td></td>
</tr>
<tr>
<td>5/549CNC – Wash St Convention Center</td>
<td>Electrical Routine Inspection (24 months)</td>
<td>24 months</td>
</tr>
<tr>
<td></td>
<td>Mechanical In-Depth Inspection (72 months)</td>
<td>72 months</td>
</tr>
</tbody>
</table>
90/22LID – Martin Luther King LID
   Electrical
       Routine Inspection (24 months)
       In-Depth Inspection (72 months)
   Mechanical
       Routine Inspection (24 months)
       In-Depth Inspection (72 months)

90/24N – Mt Baker Ridge Tunnel
   Electrical
       Routine Inspection (24 months)
       In-Depth Inspection (72 months)
   Mechanical
       Routine Inspection (24 months)
       In-Depth Inspection (72 months)

90/24S – Mt Baker Ridge Tunnel
   Electrical
       Routine Inspection (24 months)
       In-Depth Inspection (72 months)
   Mechanical
       Routine Inspection (24 months)
       In-Depth Inspection (72 months)

90/26LID – First Hill LID
   Electrical
       Routine Inspection (24 months)
       In-Depth Inspection (72 months)
   Mechanical
       Routine Inspection (24 months)
       In-Depth Inspection (72 months)

99/540 – Alaskan Way Tunnel
   Electrical
       Routine Inspection (24 months)
       In-Depth Inspection (72 months)
   Mechanical
       Routine Inspection (24 months)
       In-Depth Inspection (72 months)

304/9 – Bremerton Tunnel
   Electrical
       Routine Inspection (24 months)
       In-Depth Inspection (72 months)
   Mechanical
       Routine Inspection (24 months)
       In-Depth Inspection (72 months)
The following is a list of tunnels that require electrical and mechanical inspections in accordance with NTIS. All of these tunnels have relatively small electrical and mechanical systems. They all receive routine inspections on a 2 year cycle.

5/546REN – 5th EXP TUNNEL
5/548PN – I-5 Under N Park Plaza
5/548PS – I-5 Under S Park Plaza
5/553R – Express Lanes Tunnel
5/555E-S – E-S Ramp Tunnel
5/555N-W – N-W Ramp Tunnel
5/568S-E – I-5 Over S-E Ramp Tunnel
5/577E-S – Ravenna-S Ramp Tunnel
20/316 – Tunnel
90/165E – S-E Ramp Tunnel
90/335E-S – E-S Ramp Tunnel
90/335N-W – N-W Ramp Tunnel
90/55 – SE 35th ST Tunnel Under I-90
97/359ALT – Knapps Hill Tunnel
101/3 – Fort Columbia Tunnel
405/22A – Houser Way Tunnel
405/35E-W – I-90 Over N-W Ramp Tunnel
405/35E-S – I-90 Over S-E Ramp Tunnel
520/9LID – Evergreen Point Road LID
520/11LID – 84th Ave NE Over SR 520
520/12LID – 92nd Ave NE Over SR 520
522/15 – Roosevelt Way Tunnel
525/1S-S – S-E Ramp Tunnel Under S-S Ramp
526/12 – SR 526 Over E-N Ramp Tunnel
526/22E-N – SR 526 Over E-N Ramp Tun
## Appendix 8-F  Operations, Inspections, and Maintenance Manual List

The following is a tabulated listing of all of the OIM manuals generated by the BPO. They are updated as necessary when rehabilitations of bridge systems occur or major components are changed.

<table>
<thead>
<tr>
<th>Bridge #</th>
<th>Bridge Name</th>
<th>Manual Date</th>
<th>Revision Date</th>
<th>Document Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>12/12N</td>
<td>Wishkah River</td>
<td>Jun-03</td>
<td>Aug-08</td>
<td>M 23-25</td>
</tr>
<tr>
<td>12/12S</td>
<td>Wishkah River - Heron</td>
<td>Jun-03</td>
<td>Dec-07</td>
<td>M 23-19</td>
</tr>
<tr>
<td>12/915</td>
<td>Snake River - Clarkston</td>
<td>Jun-96</td>
<td>Feb-16</td>
<td>M 23-26</td>
</tr>
<tr>
<td>16/110E</td>
<td>Tacoma Narrows</td>
<td>Jun-95</td>
<td>--</td>
<td>*</td>
</tr>
<tr>
<td>90/25N</td>
<td>Homer M. Hadley</td>
<td>Jul-06</td>
<td>Sept-18</td>
<td>*</td>
</tr>
<tr>
<td>90/25S</td>
<td>Lacey V. Murrow</td>
<td>Jul-06</td>
<td>--</td>
<td>*</td>
</tr>
<tr>
<td>99/530E</td>
<td>Duwamish River</td>
<td>Jun-01</td>
<td>Jun-08</td>
<td>M 23-31</td>
</tr>
<tr>
<td>99/530W</td>
<td>Duwamish River</td>
<td>Jun-01</td>
<td>Jun-07</td>
<td>*</td>
</tr>
<tr>
<td>101/115</td>
<td>Chehalis River</td>
<td>Oct-99</td>
<td>Aug-16</td>
<td>M 23-23</td>
</tr>
<tr>
<td>101/125E</td>
<td>Hoquiam River - Riverside</td>
<td>Jun-97</td>
<td>Mar-13</td>
<td>M 23-22</td>
</tr>
<tr>
<td>101/125W</td>
<td>Hoquiam River - Simpson</td>
<td>Jan-12</td>
<td>--</td>
<td>M 23-33</td>
</tr>
<tr>
<td>104/5.1 &amp; 5.2</td>
<td>Hood Canal</td>
<td>Jan-15</td>
<td>Feb-16</td>
<td>M 23-12</td>
</tr>
<tr>
<td>513/12</td>
<td>Montlake Bridge</td>
<td>Nov-02</td>
<td>Feb-05</td>
<td>M 23-30</td>
</tr>
<tr>
<td>529/10E &amp; W</td>
<td>Snohomish River</td>
<td>Mar-01</td>
<td>Jun-07</td>
<td>M 23-21</td>
</tr>
<tr>
<td>529/20E &amp; W</td>
<td>Steamboat Slough</td>
<td>Jan-05</td>
<td>--</td>
<td>M 23-28</td>
</tr>
</tbody>
</table>

*Document number not yet assigned.

No OIM manuals have been developed for complex tunnels yet.