Pennsylvania Department of Transportation

Bridge Safety Inspection Manual (Publication 238)

Pittsburgh, PA

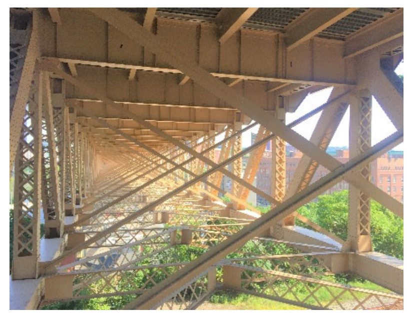
HWY22MH003

(529 pages)

Bridge Safety Inspection Manual



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PUB 238 (4-21)

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Part IP: Policy and Procedures and Part IE: Evaluation Specifications

References to the sections, equations, figures or tables contained in the following bridge manuals are designated by the following prefixes:

M	AASHTO Manual for Bridge Evaluation (MBE)
MC	Commentary to AASHTO Manual for Bridge Evaluation
IP	PennDOT Bridge Safety Inspection Manual, Pub 238, Part A "Policies and Procedures"
IE	PennDOT Bridge Safety Inspection Manual, Pub 238, Part B "Evaluation Specifications"
PP	Pub 15M - PennDOT Design Manual, Part 4, Part A "Policies and Procedures"
PD	Pub 15M - PennDOT Design Manual, Part 4, Part B "Design Specifications"
AD	AASHTO LRFD Bridge Design Specifications
SD	AASHTO Standard Specifications for Highway Bridges

In Publication 238, tables and figures are numbered consecutively within their chapter using the above prefixes. Examples of this identification format are:

Table IP 1.1-1 The first table in Chapter 1, Section 1 of the Pub 238 Policies and Procedures
Figure IE 3.2-4 The 4th figure in Chapter 3, Section 2 of the Pub 238 Evaluation Specifications

Tables and figures from the other manuals above will be identified by the above prefix and the number assigned by that manual. An example is:

Figure SD 3.7.6 Standard H Trucks (from AASHTO Standard Design Specs.)

Separate Appendices were established for each Chapter. Separate documents within each Chapter are numbered sequentially using the above prefixes. Examples are:

Appendix IP-02-A 1st Appendix supporting Chapter 2 of Publication 238 Policies & Procedures
Appendix IP-08-C 3rd Appendix supporting Chapter 8 of Publication 238 Policies & Procedures

Part IE: Evaluation Specifications

If a section is listed in the Table of Contents, it is modifying, adding to, or replacing the corresponding section of the MBE by this Part IE.

If a section or article has a suffix I, this is a new section not included in the MBE.

When Publication 238 modifies and/or adds information to an article from the MBE, the first sentence of Publication 238 shall read "*The following shall supplement Mx.x.x*."

When a Publication 238 article replaces information in an article from the MBE, the first sentence of Publication 238 shall read "*The following shall replace Mx.x.x*."

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Strike-Off-Letter	Subject	Section Where Incorporated
495-20-05	Scour Measurement and Documentation	Chapter IP 2, various sections; Appendix IP 02-E
495-20-03	Extended and Reduced Inspection Frequency	Chapter IP 2, various sections
495-20-01	Assigned Load Rating Method and Coding of the NBI Vehicle	Chapter IP 3, Chapter IP 4, Chapter IP 8, various sections; Appendices IP 03-D, 04-A and 04-B
495-19-02	Structure Emergency Closure Actions	Chapter IP 2, Section 2.13.2; Appendix IP 02-F
495-18-08	Publication 238 - Bridge Safety Inspection Manual, Chapter 3	Chapter IE 3, Section 3.8.9
495-18-02	Publication 100A - BMS2 Coding Manual, Publication 238 - Bridge Safety Inspection Manual, AASHTO/PennDOT Element Level Bridge Inspections	Chapter IP 1, Section 1.3.2 Chapter IP 2, Sections 2.3 and 2.4; Appendix IP 01-G Appendix IP 01-H
495-18-01	Review of Bridges in Critical Condition	Chapter IP 2, various sections Chapter IP 6, Section 6.2; Appendix IP 01-G Appendix IP 01-H
495-17-07	Sign Structure Asset Tags - Policy and Installation Instructions	Appendix IP 02-D
495-16-01	Underwater Inspection	Chapter IP 2, Section 2.3.2.4
495-15-10	Publication 238 - Bridge Safety Inspection Manual, Appendix IP 02-D Scope of Work and Guidelines for Sign Structure Inspections	Appendix IP 02-D
495-15-04	Publication 238 - Bridge Safety Inspection Manual, Publication 100A - BMS2 Coding Manual, Coding Improvements for Bridge Inspection Frequency and Scheduling	Chapter IP 2, various sections
495-14-16	Publication 238 - Bridge Safety Inspection Manual - Revision to Bridge Inspection Agreement Funding Categories	Chapter IP 1, Section 1.11
495-14-05	Bridge Safety Inspection Frequency Compliance	Chapter IP 2, Section 2.3.2.4
495-14-03	Posted Road Bonding Exemptions	
495-14-01	Publication 238 - Bridge Safety Inspection Manual - Revision to Appendix IP 01-D Notification to Local Bridge Owners	Appendix IP 01-D
495-13-08	Publication 238 - Bridge Safety Inspection Manual - Various Revisions Regarding Determination of Safe Load Capacity	Chapter IP 2, Section 2.2.2 Chapter IP 3, Section 3.5.1.1 Chapter IP 4, various sections Chapter IP 10, Section 10.3.2; Appendix IP 03-B Appendix IP 03-C

495-13-01	Publication 238 - Bridge Safety Inspection Manual - Revision of Appendix IP 01-K, Standard Reimbursement Agreement	Chapter IP 1, Section 1.9; Appendix IP 01-K
465-12-01	Bridge Safety Inspection - Hands-On Insp Procedures for Fatigue and Fracture Inspections	Chapter IP 2, Section 2.4.5.1 and 2.4.6
431-11-05	Publication 238 - Bridge Safety Inspection Manual - Modified Inspection Frequency for PennDOT-Owned Bridges from 8 ft to 20 ft Long	Chapter IP 1, Section 1.5.7.4
431-11-11	Publication 238 - Bridge Safety Inspection Manual - Plan of Action for Critical Deficiencies and Plan of Action for Scour Critical Bridges for Local and Other Owner Bridges	Chapter IP 1, Section 1.7.2.4 Chapter IP 2, Section 2.13.2; Appendix IP 01-D Appendix IP 01-G Appendix IP 01-H
431-10-09	Bridge Safety Inspection Manual Publication 238, 2nd Edition, Revision March 2010	All

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Section No.	Description of Revision
All Applicable	Updated version and date of release.
All Applicable	Added references to NTI and NTIS and incorporated tunnel language where applicable.
All Applicable	Replaced "Bureau of Design (BOD)" with "Bureau of Maintenance and Operations (BOMO)".
All Applicable	Replaced "Bridge Quality Assurance Division(BQAD)" with "Bridge Inspection Section(BIS)"
All Applicable	Replaced "Chief Bridge Engineer" with "Bridge Inspection Section Chief".
All Applicable	Updated formatting for more consistency throughout.
All Applicable	Updated for gender neutral language.
All Applicable	Incorporated all active Strike-Off Letters.
All Applicable	Moved policy and procedure information from IE Chapters to IP Chapters.
All Applicable	Removed reference to EDMS Documents and replaced with ECS throughout.
All Applicable	Removed the term "structurally deficient" throughout.
All Applicable	Updated references to other manuals and Pub 238 IE chapters as required.
Intro	Updated date on Cover and references in Preface. New list of Strike-Off Letters Incorporated and Summary of Revisions. Updated abbreviations list based on the abbreviations used in the Manual. Updated Glossary to remove terms included in the abbreviations list and added NTIS and Tunnel.
IP TOC	Added abbreviated TOC listing major headings only. Updated to match changes throughout.
IP 1.1	Added paragraph explaining the two parts of the manual.
IP 1.2	Describe how tunnel relates to bridge throughout the Manual.
IP 1.3.2	Updated list of references to indicate current versions of all shall be used and added tunnel references.
IP 1.3.3	Added many new references which were included in different locations throughout the Manual and current Scope of Work documents.
IP 1.3.4	Updated procedure on how to request revisions to Bridge Inspection Section Manuals.
IP 1.5	Updated terminology to include tunnels and clarify which miscellaneous structures are included in this Manual.
IP 1.5.7.6	Added new section for NTIS Tunnels.
IP 1.6.1.1	Added reference to the 2009 revisions to the NBIS.
IP 1.6.1.2	Added new section for NTIS.
IP 1.7.2.1	Updated requirements under heading 'Department Highway Bridges' and added requirement under heading 'Non-NBIS Highway Bridges'.
IP 1.7.2.4	Revised timeframe for local notification letters to be sent to January/February in order to meet the 60 day time limit for notification of the April inspections.
IP 1.7.3.1	Updated references to scope of work appendices (last paragraph).
IP 1.7.3.2	Updated 1.d to be less specific. Added sentence indicating HOPS and HOA shall be amended to include inspection requirements when possible.
IP 1.9	Revise reference to Appendix 01-K to nowreference RAS instead.
IP 1.10.2	Deleted dead link at end of section. Added reference of how to locate Pink Sheet.
IP 1.10.3	Deleted old section 1.10.3.1 and appendix it referenced. Renumbered consecutive headings within 1.10.3. Deleted language referencing Cost Plus Fixed Fee Agreements.
IP 1.10.4.1	Updated list of appendices for SOW of bridges and tunnels. Added timeframe for tunnel inspection reports to be completed.
IP 1.11	Revised Table IP 1.11-1.
IP 1.12.2.1	Update crane numbers in table.
IP 2.1.1	Updated descriptions for first four titles listed under 'District Bridge Unit' heading.
IP 2.1.3	Added qualifications for Program Manager and Tunnel Safety Inspector.
IP 2.1.3.2	Added grace period of 12 months after date of hire for inspectors to become certified.
IP 2.2.2	Added reference to the TOMIE for tunnel ratings.

Section No.	Description of Revision
IP 2.3	Added reference to TOMIE and tunnel specific language throughout.
IP 2.3.1.5	Added recommendation to complete inventory information prior to field visit for initial inspection. Added reference to IP 2.3.
IP 2.3.2.3	Added two bullets to item 1.
IP 2.3.2.4	Moved language about Other Special (Interim) inspections under heading "Reduced Interval Inspections for Bridges" to IP 2.3.5.
IP 2.3.2.5	Moved "Monitoring of Inspection Interval for NBIS/NTIS Compliance" from IP 2.3.2.5 to IP 2.3.6 and renumbered IP 2.3.2.6 to IP 2.3.2.5. Added description of when element level data is required for a routine inspection and added reference to IP 2.3. Deleted language related to first-time collection of element-level data.
IP 2.3.3.5	Added clarification of when element-level data is needed for Damage inspections. Added reference to IP 2.3.
IP 2.3.4.4	Deleted coding language which was repeated from previous section.
IP 2.3.4.5	Added reference to IP 2.3.
IP 2.3.5.2	Updated language regarding inspections which do not meet the scope of Other Special.
IP 2.3.5.3	Combined second paragraph with language from IP 2.3.2.4.
IP 2.3.5.4	Deleted last sentence of first paragraph and entire last paragraph.
IP 2.3.5.5	Added clarification of when element-level data is needed for Other Special Inspections. Added reference to IP 2.3.
IP 2.3.6	Moved Monitoring of Inspection Interval for NBIS/NTIS compliance from IP 2.3.2.5 to IP 2.3.6 and added numbers for subheadings. Added paragraph explaining compliance inspection types.
IP 2.3.6.2	Added Damage and In-Depth inspections. Added language for time allowance for unusual circumstances.
IP 2.3.6.4	Added NTIS Compliance inspection types to table IP 2.3.6.4-1. Deleted second table in this section (previously Table IP 2.3.2.5-2).
IP 2.3.6.6	Added Table IP 2.3.6.6-2 for Coding of Tunnel Inspections.
IP 2.4.4.2	Revised end of paragraph for clarity.
IP 2.4.4.3	Revised end of paragraph for clarity.
IP 2.4.5.1	Add reference to new Appendix IP 02-H for F&F Plan Cover Page.
IP 2.4.8	Revised "Routine" to "Fracture Critical."
IP 2.4.9.1	Updated references to tables found in AASHTO. Reference previously pointed to AASHTO Standard Specifications for Highway Bridges, but was revised to use the corresponding tables in AASHTO LRFD Design Specifications. Deleted reference to the “PTF.”
IP 2.5.2	Added reference to IE 3.8.9.
IP 2.5.4	Revised time frame for inspection of masonry arch culverts to between April 1 and April 30 for all Routine and Interim inspections. Previously they had to be inspected by April 15, with no early timeframe specified.
IP 2.6.2.3	Revised "Routine" to "Underwater."
IP 2.6.4	Revised reference to Publication 23 throughout. Added reference to Bridge Watch as appropriate.
IP 2.8	Revised end of paragraph for clarity.
IP 2.9.1	Added reference to new appendix. Updated language for reporting BPR. Revised list of contacts for BPR reporting.
IP 2.9.3	Updated name of appendix.
IP 2.9.4	Updated the last two paragraphs for clarity.
IP 2.10.2	Clarified inspection reports to be sealed by a PA PE.
IP 2.11.4	Updated name of appendix.
IP 2.13	Updated heading name.
IP 2.13.3	Added new section for Tunnel Maintenance Categories and sub section for Critical Findings.

Section No.	Description of Revision
IP 2.14	Added statement for critical findings in tunnels.
IP 2.14.1	Added section for Tunnels with Critical Findings.
IP 2.14.2	Added section for Tunnel Owner.
IP 2.15.1	Updated heading name.
IP 2.15.5	Added new section.
IP 3.1	Updated reference from Condition Evaluation of Bridges to Manual for Bridge Evaluation (throughout IP 03). Listed load rating methods allowed by PennDOT.
IP 3.2.2.2	Deleted reference to outdated procedure for ML80 Vehicle, Special Considerations. Deleted language about permit vehicles at end of section.
IP 3.2.2.3	Deleted language dealing with design vehicles and renamed heading.
IP 3.2.2.4	New Section: AASHTO Special Hauling Vehicles
IP 3.2.2.5	New Section: FHWA FAST Act Emergency Vehicles
IP 3.3.3.1	Deleted last paragraph.
IP 3.5	Renumbered from IP 3.4.6 to IP 3.5. Renumbered remaining sections through the end of IP 03.
IP 3.6.1	Update 5th paragraph to indicate LF or LRFD ratings can be used in APRAS.
IP 3.9	Deleted old IP 3.9 (Analysis of Reinforced Concrete Piers).
IP 4.2	Added NTIS.
IP 4.4.2	Clarified the maximum posting of HS20 combination of 40 Tons. Revised weight for a loaded school bus in last paragraph.
IP 4.7	Added reference to Publication 236 throughout.
IP 4.4.7.3	Deleted last paragraph.
IP 4.6.2	Labeled each bullet Case 1 through Case 3 for clarification in next section.
IP 4.6.3	Updated to reference the posting approval via the Case number listed in IP 4.6.2 instead of approval person. Revised list of people to receive a copy of posting letter for Case 3. Added reference to IP 06 in last paragraph.
IP 4.8.2	Updated fifth paragraph to indicate all bridges with posted vertical clearance shall have an advance warning sign.
IP 5.1	Added sentence to first paragraph from IE 1.5. Revised second paragraph to remove statistical data, list structure types and reference Pub 100A.
IP 5.2	Revised first paragraph to be less specific. Deleted list of BMS2 Data Screens and added reference to Pub 100A. Revised other paragraphs with minor changes.
IP 5.3.2	Deleted "ePortfolio" throughout. Deleted unnecessary paragraphs.
IP 5.4	Revised last paragraph to reference Pub 100A for new location of profile data for BMS2 users.
IP 5.4.1	Added clarification at end of section for Department vs non-Department employees.
IP 5.4.2	Updated paragraph for clarity.
IP 6.2.2	Deleted last sentence of first bullet under "Bridge Inspection Team Leader Required Actions." Updated time frame to upload inspection data to BMS2 under second bullet. Deleted first bullet under "Engineer-in-Charge (District Bridge Engineer) Required Actions."
IP 6.2.3	Deleted first bullet under "District Bridge Engineer."
IP 6.2.6	Revised first sentence of first paragraph.
IP 6.3	Deleted third paragraph. Revised quantity of bridges to be inspected as part of the QA program. Added new paragraph indicating a link will be added to BMS2 to quickly clarify issues uncovered during QA inspections. Removed reference to the Turnpike and replaced with reference to other agency owners throughout all of IP 6.3. Minor clarifications/edits throughout all of IP 6.3.
IP 6.3.1	Move language to Task VI which was previously in IP 6.3.2.3.
IP 6.3.2	Deleted first paragraph which is already stated in IP 6.3. Added new paragraph at end of section.

Section No.	Description of Revision
IP 6.3.2.1	Deleted reference to appendix which was removed from the document.
IP 7	Deleted specifics about each training class and referenced the Training Calendar within ECMS. Added IP 7.2.3.
IP 8.1	Revised last paragraph.
IP 8.3.1	Revised language under Inspection Photos bullet and deleted bullet for Video of bridge site. Added four bullets at end of list.
IP 8.3.2	Clarified Load Rating Summary Form to be sealed by a PA PE.
IP 8.3.5	Added bullet for Scour Plan of Action.
IP 8.3.6	Added bullets for Material Certifications and Technical Specifications.
IP 8.3.7	Added three bullets to the end of the list.
IP 8.3.8	Added paragraph at end for tunnels.
IP 8.5.1	Deleted list of D-491 Forms and added reference to Pub 100A for this data.
IP 8.5.2	Added "element-level data" to first paragraph. Added bullets for N-Notes and T-Tunnels. Revised last paragraph for clarity.
IP 8.5.4	Edited last paragraph for clarity.
IP 9.1	Added two bullets to the first list.
IP 9.2	Deleted reference to appendix (removed from document) and added reference to BIRM.
IP 9.4	Added "or District Traffic Unit" to second paragraph.
IP 10.2.3	Deleted last sentence of first paragraph. Revised second paragraph.
IP 10.3.3	Added subheading for "Dual Lane Transporter" at end of section.
IP 10.3.7	Revised entire paragraph.
IP 10.4.2	Added new paragraph at end of section.
IP 10.5	Replaced "FMIS" and "COIN" with "SAP."
IP 10.5.1	Added reference to new appendix.
TOC for IP Appendices	Updated for changes to appendices throughout.
Appendix IP 01-A	Updated strategies for Asset Management (page 3), Standardized/Consistent Equipment (page 4), and Quality Control and Quality Assurance (page 5) objectives. Updated formatting.
Appendix IP 01-B	Updated for 2009 revisions (section §650.305 and §650.317). Updated formatting.
Appendix IP 01-C	New appendix.
Appendix IP 01-D	Added new bullets to list in beginning. "Critical Structural Deficiencies" - revised paragraph for clarity."Scour Critical Bridges and Scour Plans of Action" - clarified which bridges require Scour POA. Updated links. "Notification of Inspection Due Dates" - revised time frame for inspection of past-due bridges in second paragraph."Inspection Agreements with PennDOT" - added new language to clarify section."Bridge Posting Requirements" - added new section."Bridge Closure Reporting" - added new section.
Appendix IP 01-E	Revised the title. Clarified references in first paragraph were to Publication 238. Updated formatting.

Section No.	Description of Revision
Appendix IP 01-F	Deleted old App IP 01-F and renamed IP 01-G to IP 01-F. Updated formatting. Statement of Work: Deleted list of references and added reference to Pub 238 for list. Scope: I.B. - Added language for extended interval. I.C. - Updated second paragraph to be consistent with other sections. II.B.1.f - Deleted "with repair costs." III.C - Added "where applicable or attainable" (first paragraph). Edited 6B26, 6C35-6C38. IV.A. - Revised the last sentence of the paragraph. IV.H. - Added new sentence at end of paragraph. V.B. - Deleted last sentence. V.E. - Added language clarifying sketch requirements. VI.A. - Deleted second sentence. VII. - Clarified that new photographs shall be taken to show current conditions. Added to the list of photos to include. Deleted last sentence in paragraph. VIII.D. - Deleted "IM10 - Estimated Cost." XIII. - Clarified that the reference in the first paragraph is to Pub 238. Revised second paragraph to be consistent with the first. Scope Deliverables: I.B.1. - Added BRKEY and clarified PA PE Seal required. I.D.4. - Deleted references to cost. III.D. - Revised time period to days for consistency. III.E. - Revised to indicate electronic submissions preferred over hard copy. III.F. - Revised to indicate electronic submissions preferred over hard copy. Exhibit 1 - Added reference to table of Work Categories added on next sheet. Table 1 - Revised to be complete list of Work Categories only. Tables 2 -4 - Deleted.
Appendix IP 01-G	New appendix for scope of work for tunnel inspections.
Appendix IP 01-H	Added Description, Objective, and Statement of Work for consistency with General SOW for Bridges. Deleted list of references and added reference to Pub 238 for list. Scope: VI. - Clarified that new photographs shall be taken. Deleted first two sentences of second paragraph. VII.A.7. - Added new line. VII.B.1. - Revised to indicate electronic submission preferred over hard copy. VII.B.2. - Revised to indicate electronic submission preferred over hard copy. VIII.A & B - Revised language for consistency. XII.A. - Clarified that the reference is to Pub 238. XVII. - Clarified that the reference is to Pub 238. Updated second paragraph to be consistent with the first. Exhibit 1 - Revised entire sheet. Updated formatting.
Appendix IP 01-I	Revised the title. Deleted all of scope except for minimum inventory and inspection information. Referenced General SOW for Bridges for all other information. Moved information from section 3 to table in section 1. Updated formatting.
Appendix IP 01-J	Updated and added references throughout. Updated formatting. Renamed heading B and revised text to be consistent with changes to SOW document.
Appendix IP 01-K	Deleted.
Appendix IP 02-A	Added language on use of Bridge Watch for monitoring. 4.1 Updated reference for Pub 23. 4.2 Updated reference for Pub 23. Deleted option to fax monitoring log submission.
Appendix IP 02-B	Updated instructions to be consistent with Pub 238 IP 02 changes. Updated formatting.
Appendix IP 02-C	Revised the title. Updated formatting. Removed “Esperant” throughout.
Appendix IP 02-D	Revised the title. Combined what appeared to be two separate documents into one continuous document. Added language throughout for replacement of light bulbs to be included with the inspection work. I.B - Deleted list of references and added reference to Pub 238 for the list.

Section No.	Description of Revision
	IV. - Changed "Frequency" to "Interval." X. - Clarified that photographs are to be new. XI. - Deleted reference to physical submissions and cost. Clarified that PA PE to seal report. Clarified that photographs are to be new. XV. - Added reference to Pub 238. XVII. - Revised last paragraph for consistency. XVIII. - Deleted reference to physical submissions. Updated formatting.
Appendix IP 02-E	Updated formatting.
Appendix IP 02-F	Revised the title. Updated formatting.
Appendix IP 02-G	New appendix.
Appendix IP 02-H	New appendix.
Appendix IP 03-A	Updated formatting.
Appendix IP 03-B	Clarified reference to IP sections were for Publication 238. Updated references. Updated formatting.
Appendix IP 04-A	Revised the title. Updated formatting.
Appendix IP 04-B	Added optional attachment of approximate vehicle weights for standard vehicles.
Appendix IP 05-A	Deleted.
Appendix IP 06-A	Deleted.
Appendix IP 09-A	Deleted.
Appendix IP 10-A	Updated formatting. Added lines to Table A for Load Types 38D, 50I, 50K, 50L, 50M, and 50X and minor text revisions to other lines. Minor text revisions throughout Table B.
Appendix IP 10-B	Updated formatting. Added reference to LRFD design programs on second page.
Appendix IP 10-C	New appendix.

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AAR	Association of American Railroads
AASHTO	American Association of State Highway and Transportation Officials
ABAS	Automated Bridge Analysis System
AD	AASHTO LRFD Bridge Design Specifications
ADT	Average Daily Traffic
ADTT	Average Daily Truck Traffic
AMD	Asset Management Division
APRAS	Automated Permit Routing Analysis System
ASD	Allowable Stress Design
ASR	Allowable Stress Rating
ATTT	Access Roads to Tandem Trailer Truck Network
BDTD	Bridge Design and Technology Division
BICT	Bridge Inspection Crane Technician
BICTS	Bridge Inspection Crane Technician Supervisor
BIRM	Bridge Inspector’s Reference Manual
BIS	Bridge Inspection Section
BITM	Bridge Inspection Training Manual
BMS2	Bridge Management System 2
BOD	Bureau of Design
BOMO	Bureau of Maintenance and Operations
BOPD	Bureau of Project Delivery
BPR	Bridge Problem Report
BQAD	Bridge Quality Assurance Division
CFR	Code of Federal Regulations
CRF	Critical Ranking Factor
CVN	Charpy V-Notch
DCNR	Department of Conservation and Natural Resources
DM4	Publication 15M, PennDOT Design Manual Part 4, Structures
ECMS	Engineering & Construction Management System

ECS	Enterprise Content Services
EDC	Electronic Data Collectors (Collection)
EIB	Encased I-Beam (IE-6)
EV	Emergency Vehicle
F&F	Fatigue and Fracture
FAST	Fixing America's Surface Transportation
FCM	Fracture Critical Member
FCP	Fracture Control Plan
FHWA	Federal Highway Administration
FO	Functionally Obsolete
FOIA	Freedom of Information Act
FPN	Federal Project Number
FRA	Federal Railway Administration
GIS	Geographic Information System
GRS	Geosynthetic Reinforced Soil
GVW	Gross Vehicle Weight
H&H	Hydrologic and Hydraulic
HBP	Highway Bridge Program
HOA	Highway Occupancy Agreement
HOP	Highway Occupancy Permit
***i*Forms**	PennDOT's software application for electronic data collection of Bridge Inspection Information
IE	PennDOT Bridge Safety Inspection Manual, Pub 238, Part A "Policies and Procedures"
IP	PennDOT Bridge Safety Inspection Manual, Pub 238, Part B "Evaluation Specifications"
IR	Inventory Rating
LFD	Load Factor Design
LFR	Load Factor Rating
LOBSTORs	Locally Owned Bridges on State Owned Roads
LRFD	Load and Resistance Factor Design
LRFR	Load and Resistance Factor Rating

M / MBE	AASHTO Manual for Bridge Evaluation
MC	Commentary to AASHTO Manual for Bridge Evaluation
MPMS	Multi-Modal Project Management System
MPT	Maintenance and Protection of Traffic
MSE	Mechanically Stabilized Earth
MUTCD	Manual of Uniform Traffic Control Devices
NARA	National Archives and Records Administration
NBI	National Bridge Inventory
NBIS	National Bridge Inspection Standards
NDT	Non-Destructive Testing
NCHRP	National Cooperative Highway Research Program
NHS	National Highway System
NICET	National Institute for Certification in Engineering Technologies
NSBA	National Steel Bridge Alliance
NTI	National Tunnel Inventory
NTIS	National Tunnel Inspection Standards
OCC	Office of Chief Counsel
OR	Operating Rating
OSA	Observed Scour Assessment
OSA	Other State Agency
OSAB	Observed Scour Assessment for Bridges (IP-2)
PA	Pennsylvania
PD	Pub 15M – PennDOT Design Manual, Part 4, Part B “Design Specifications”
PE	Professional Engineer
PennDOT	Pennsylvania Department of Transportation
PP	Pub 15M – PennDOT Design Manual, Part 4, Part A “Policies and Procedures”
PSP	Pennsylvania State Police
PTC	Pennsylvania Turnpike Commission
PUC	Public Utility Commission

QA	Quality Assurance
QC	Quality Control
RAS	Reimbursement Agreement System
RCRS	Road Condition Reporting System
RF	Rating Factor
RMS	Roadway Management System
ROW	Right of Way
RT	Rating
RTKA	Right to Know Act
SAR	Scour Assessment Rating
SCBI	Scour Critical Bridge Indicator
SD	AASHTO Standard Specifications for Highway Bridges
SHVs	Special Hauling Vehicles
SI&A	Structure Inventory and Appraisal
SLC	Safe Load Capacity
SNBIBE	Specifications for the National Bridge Inventory Bridge Elements
SNTI	Specifications for the National Tunnel Inventory
SOL	Strike-Off Letter
SOW	Scope of Work
SR	Sufficiency Rating
SR ID	State Route Identification
USGS	United States Geological Survey
TOMIE	Tunnel Operations, Maintenance, Inspection, and Evaluation
TTTN	Tandem Trailer Truck Network
VMS	Variable Message Signs
WBS	Work Breakdown Structure

Appraisal Rating: An evaluation of a functionality of a bridge characteristic or component in comparison to current standards for the highway system the bridge serves.

Bridge: A structure, including supports, erected over a depression or an obstruction, such as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads.

Bridge Management System 2 (BMS2): A system designed to optimize the use of available resources for the inspection, maintenance, rehabilitation, and replacement of bridges.

Bridge Owner: An organization or agency responsible for the inspection, load rating, and maintenance of highway bridges.

Condition Rating: An evaluation of the physical condition of a bridge component in comparison to its original as-built condition.

Culvert: A soil interaction structure in an embankment that functions as a bridge. This structure may carry a highway, railway or pathway over a waterway, railway, highway or pathway. Culvert structure types include pipes, pipe arches, boxes and rigid frames and may be constructed of various materials.

Load Rating: The determination of the live load carrying capacity of an existing bridge using existing bridge plans supplemented by information gathered from a field inspection.

National Bridge Inspection Standards (NBIS): Federal regulations establishing requirements for inspection procedures, frequency of inspections, qualifications of personnel, inspection reports, and preparation and maintenance of bridge inventory records. The NBIS apply to all structures defined as bridges (see IP 1.5.7.3) located on or over all public roads.

National Bridge Inventory: Inventory containing SI&A information for the nation's NBIS bridges.

National Tunnel Inspection Standards (NTIS): Federal regulations establishing requirements for inspection procedures, frequency of inspections, qualifications of personnel, inspection reports, and preparation and maintenance of tunnel inventory records.

National Tunnel Inventory: Inventory containing SI&A information for the nation's NTIS tunnels.

Quality Control (QC): Quality control is the enforcement, by a supervisor, of procedures that are intended to maintain the quality of a product or service at or above a specified level.

Quality Assurance (QA): Quality assurance is the independent verification or measurement of the level of quality of a sample product or service.

Representative Load: A live load configuration used to represent/envelop a group of live loads with similar axle spacings and weights.

Structure Inventory and Appraisal Sheet (SI&A): A summary sheet of bridge data required by NBIS.

Tunnel (from NTIS): An enclosed roadway for motor vehicle traffic with vehicle access limited to portals, regardless of type of structure or method of construction, that requires, based on the owner's determination, special design considerations that may include lighting, ventilation, fire protection systems, and emergency egress capacity.

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1.1 PURPOSE OF THIS MANUAL

The purpose of the Bridge Safety Inspection Manual is to compile the policies and procedures of the Pennsylvania Department of Transportation (herein referred to as the Department) as related to the Bridge Safety Inspection Program to ensure:

1. Public safety
2. Compliance with Federal and State regulations
3. Uniformity in inspection, evaluation, and load rating of Pennsylvania's public road bridges and tunnels
4. Accurate and adequate information to manage bridges and tunnels as a critical infrastructure asset.

This Manual is separated into two parts. Part IP covers the Department specific policies and procedures. Part IE follows along and directly modifies the Manual for Bridge Evaluation (MBE) for Department specific preferences as applicable. It is intended that this Manual be used by all persons involved in bridge and tunnel safety inspection activities along with the MBE and other references in IP 1.3.

This Manual is a revision of the Bridge Safety Inspection Manual, Publication 238, 2^{nd} Edition dated March 2010.

1.2 SCOPE OF THIS MANUAL

The provisions of this Manual are intended for the safety inspection and management of bridges, culverts and tunnels involving public roads in Pennsylvania. This Manual also provides guidance on safety inspection of retaining walls and sign structures.

The term "bridge" as used throughout this manual shall be considered synonymous with "culvert" and "tunnel," as applicable, unless otherwise noted or implied. When NBIS or NBI is referenced, then bridge is intended to mean bridge. When NTIS or NTI is referenced, the information given only applies to tunnels. When both NBIS/NTIS or NBI/NTI are used, then bridge means bridge or tunnel.

This Manual will provide guidance on the following aspects:

1. Responsibilities of various parties for bridge safety inspections
2. Technical standards and specifications for bridge inspection, load rating and posting
3. Administrative requirements to meet State and Federal regulations regarding recording and reporting inspection information

Provisions are not included for bridges used solely for railway, rail-transit, or public utilities that are not related to public highways. For bridges not fully covered herein, the provisions of this Manual may be applied, as augmented with additional inspection and rating criteria where required.

This Manual is not intended to supplant proper training or the exercise of judgment by the Engineer, and states only the minimum requirements necessary to provide for public safety. The Owner or Engineer may require the sophistication of inspection, load rating or the testing of materials to be higher than the minimum requirements.

The Bridge Safety Inspection Program Strategic Plan (see Appendix IP 01-A) was developed to guide the Department toward successful implementation of its goals. This Manual supports the Strategic Plan mission, goals and objectives and will be updated as necessary.

The concepts of safety through redundancy and ductility and of protection against deterioration and scour are emphasized.

The Commentary located within the IE chapters of this Manual is not intended to provide a complete historical background concerning the development of this Manual, nor is it intended to provide a detailed summary of the studies and research data reviewed in formulating the provisions of this Manual. References are provided for those who wish to study the background material in depth.

The Commentary directs attention to other documents that provide suggestions for carrying out the requirements and intent of this Manual. However, those documents and this Commentary are not intended to be a part of this Manual.

PennDOT has a decentralized Bridge Safety Inspection Program that follows the guidelines and standards established by the Federal Highway Administration (FHWA) and The American Association of State Highway and Transportation Officials (AASHTO). Each District's Bridge Unit manages and administers the inspection of Department and local bridges in its area. PennDOT's Central Office, Bridge Inspection Section (BIS) within the Bureau of Maintenance and Operations (BOMO), is responsible for overall guidance and coordination of PA's inspection program.

Bridge safety inspection provides information on each bridge that is needed to complete and update each bridge's inventory/inspection record. This data resides in the Bridge Management System 2 (BMS2) that was implemented November, 2006. This system accepts, stores, updates and reports physical and operating characteristics for all public bridges in Pennsylvania.

1.3 APPLICABLE SPECIFICATIONS AND STANDARDS

1.3.1 FHWA Requirements

1.3.1.1 NATIONAL BRIDGE INSPECTION STANDARDS

The National Bridge Inspection Standards (NBIS) were developed after the 1968 Federal Highway Act became effective and were first published as a notice in the Federal Register, Volume 36, No. 81, Page 7851 on April 27, 1971. The NBIS have been amended several times by the Federal Highway Administration to include new provisions for fracture critical inspections, scour evaluations, and underwater inspections.

The NBIS are, therefore, mandated by Federal Law and are intended to ensure the proper inspection of the nation's bridges more than 20 feet in length on public roads. The National Bridge Inspection Standards are included in subpart C of Part 650 of Code of Federal Regulations (CFR), Title 23 - Highways. A copy of the current NBIS is included in Appendix IP 01-B.

The Federal Highway Administration gives policy guidance and establishes criteria and priorities for matching funds under various programs. In addition, FHWA reviews the results of those programs for compliance with the Standards through its annual compliance review.

1.3.1.2 NATIONAL TUNNEL INSPECTION STANDARDS

The National Tunnel Inspection Standards (NTIS) were developed to require tunnel owners to establish an inspection program, maintain an inventory database, and report critical findings to FHWA as set forth in the Moving Ahead for Progress in the 21st Century Act (MAP-21). FHWA first solicitated public comment for the initial requirements for NTIS in 2008. The final rule establishing the NTIS is effective August 2015 and address comments from numerous State DOT's and engineering organizations among others. The NTIS are mandated by Federal Law and are included in subpart E of Part 650 of CFR, Title 23 - Highways. A copy of the current NTIS is included in Appendix IP 01-C.

1.3.2 Inspection Specifications

The latest versions of the following specifications, unless otherwise modified in this Manual, shall govern the safety inspection of bridges listed in the following order of precedence:

1) PennDOT Bridge Safety Inspection Manual, Publication 238 including all changes via Strike-off Letters (SOLs)

2) PennDOT Design Manual Part 4 Structures, Publication 15M

3) Title 23 Highways Code of Federal Regulations Part 650 Subpart C – National Bridge Inspection Standards

4) Title 23 Highways Code of Federal Regulations Part 650 Subpart E – National Tunnel Inspection Standards

5) AASHTO Manual for Bridge Evaluation

6) AASHTO Manual for Bridge Element Inspection

7) FHWA Tunnel Operations, Maintenance, Inspection, and Evaluation (TOMIE) Manual

8) FHWA Specifications for the National Tunnel Inventory

9) AASHTO LRFD Bridge Design Specifications

10) AASHTO Standard Specifications for Highway Bridges

11) AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals

12) AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals

13) PennDOT BMS2 Coding Manual, Publication 100A

14) FHWA Manual of Uniform Traffic Control Devices

15) FHWA Guidelines for the Installation, Inspection, Maintenance and Repair of Structural Supports for Highway Signs, Luminaires, and Traffic Signals (FHWA-NHI-05-036)

16) PennDOT Traffic Engineering Manual, Publication 46

17) PennDOT Temporary Traffic Control Guidelines, Publication 213

1.3.3 Other Inspection Manuals and References

- FHWA Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation’s Bridges (FHWA-PD-96-001)
- FHWA Bridge Inspector’s Reference Manual (FHWA-NHI-12-049)
- FHWA Specification for the National Bridge Inventory Bridge Elements
- FHWA Inspection of Fracture Critical Bridge Members (FHWA-IP-86-26)
- FHWA Underwater Bridge Inspection Manual (FHWA-NHI-10-027)
- FHWA Underwater Bridge Repair, Rehabilitation, and Countermeasures (FHWA-NHI-10-029)
- FHWA Technical Manual for Design and Construction of Road Tunnels – Civil Elements (FHWA-NHI-10-034)
- FHWA Reference Guide for Load Rating of Tunnel Structures (FHWA-HIF-19-010)
- FHWA Hydraulic Engineering Circular No. 18, Evaluation Scour at Bridges (FHWA-HIF-12-003)
- FHWA Hydraulic Engineering Circular No. 20, Stream Stability at Highway Structures (FHWA-HIF-12-004)
- FHWA Hydraulic Engineering Circular No. 23, Bridge Scour and Stream Instability Countermeasures: Experience, Selection, and Design Guidance (FHWA-NHI-09-111)
- NHI Publication 02-037: Fracture Critical Inspection Techniques for Steel Bridges
- Technical Advisory: Evaluating Scour at Bridges, T 5140.23
- Technical Advisory: Load-carrying Capacity Considerations of Gusset Plates in Non-load-path-redundant Steel Truss Bridges, T 5140.29
- Technical Advisory: Inspection of Gusset Plates Using Non-Destructive Evaluation Technologies, T 5140.31.
- Manual for Inspecting Bridges for Fatigue Damage Conditions, Research Project No. 85-02.

- AASHTO Moveable Bridge Inspection, Evaluation, and Maintenance Manual
- AASHTO LRFD Road Tunnel Design and Construction Guide Specifications
- AASHTO Guide Specifications for Internal Redundancy of Mechanically Fastened Built-Up Steel Members
- AASHTO Guide Specifications for Analysis and Identification of Fracture Critical Members and System Redundant Members
- PennDOT Handbook of Approved Signs, Publication 236
- PennDOT Bureau of Design Standards for Bridge Construction, BC-700M Series, Publication 219M
- PennDOT Bureau of Design Standards for Bridge Design, BD-600M Series, Publication 218M
- PennDOT Bureau of Design Standards for Roadway Construction, RC 1M to 100M Series, Publication 72M

1.3.4 Modifications to PennDOT Inspection Publications

Revisions to Department manuals listed in IP 1.3.4.1 shall adhere to the following procedure. Whenever a user believes that modifications (including additions) would improve the present bridge safety inspection practices and procedures, the recommended modification shall be transmitted to the Bridge Inspection Section Chief. Upon receiving the proposed modification request, the following steps will occur:

(a) The Bridge Inspection Section Chief will review the recommended modification and determine if the change adds value and is worthwhile.
(b) If in agreement, the Bridge Inspection Section Chief will oversee the changes as they are made to the documents in question and take appropriate action, including obtaining comments by means of a Clearance Transmittal Letter and securing FHWA approval if applicable.
(c) The revised or added page(s) will be distributed publicly via a Strike-Off Letter.
(d) If the proposed modification is not accepted, the Bridge Inspection Section Chief, will notify the originator of the reason for its rejection.

1.3.4.1 APPLICABLE MANUALS

This modification procedure applies to the following Department inspection manuals:

- Bridge Safety Inspection Manual, Policies and Procedures, Publication 238
- Bridge Safety Inspection QA Manual, Publication 240
- Bridge Management System 2 Coding Manual, Publication 100A

1.4 INSPECTION PROGRAM ACTIVITIES

In addition to the field inspection and bridge rating, many activities by various parties are needed for a successful statewide bridge safety inspection and management program. While specific responsibilities are detailed in the various sections of this Manual, an outline of the bridge inspection activities is as follows:

<u>FHWA</u>

- Annual Report to Congress on the condition of the nation's bridges
- Establishment of criteria for NBI/NTI data
- Collection and compilation of NBI/NTI data for all states
- Verification of NBIS/NTIS compliance for all states
- Provision of federal monies for bridge inspection
- Inspection of Federal Lands bridges in PA

<u>PennDOT Bridge Inspection Section (BIS)</u>

- Development of policies and procedures for the bridge inspection and management
- Collection and compilation of all bridge inventory and inspection data for all public roads in PA
- Development and analysis of bridge information for statewide planning needs
- Verification and assurance of PA's compliance with NBIS/NTIS
- Reporting of PA's NBI/NTI data to FHWA
- Maintenance and operation of PA's BMS2
- Management of Statewide QA program for safety inspection

- QC of State Bridge Postings
- Maintenance of a Training and Certification program for bridge and tunnel safety inspectors
- Coordination of statewide Scour Assessment program
- Maintenance of statewide Federal Aid agreements for bridge inspection
- Maintenance of statewide open-end engineering agreements for the underwater inspection of state and local bridges
- Maintenance of statewide open-end engineering agreements for the NBIS inspection of state and local bridges
- Coordination of statewide bridge inspection crane utilization
- Maintenance of software for electronic data collection (*i*Forms) and uploading to BMS2 of bridge inspection information

<u>PennDOT Engineering Districts, DCNR, and PTC</u>

- NBIS/NTIS compliance for all of the bridges for their respective jurisdictions
- Maintenance of an adequate and qualified in-house bridge inspection staff
- QC of their bridge inventory and inspection data/reports
- QC of local bridge inspection reports (Districts only)
- QC of bridge restrictions on local bridges
- Data entry into BMS2
- Review and approval of bridge posting recommendation for selected routes
- Establishment of engineering and/or reimbursement agreements for inspection of their bridges, as needed
- Establishment of engineering and/or reimbursement agreements for inspection of non-State bridges in their jurisdiction, as needed (Districts only)
- Operation and maintenance of PennDOT's bridge inspection crane fleet (Home Districts only)

<u>Other Bridge Owners</u>

- Inspection and rating of all bridges (by in-house staff or by consultant)
- NBIS/NTIS compliance
- Development of bridge posting recommendations for approval
- Establishment and maintenance of proper bridge postings
- Reporting of BMS2 data to Districts for input into BMS2

1.5 GENERAL INSPECTION PROGRAM TERMINOLOGY

For a comprehensive list of terminology, see the Glossary at the beginning of this Manual. Definitions for terminology commonly used in the Bridge Safety Inspection Program are as follows:

1.5.1 Bridge/Tunnel

A bridge is 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.

A tunnel as defined by NTIS is an enclosed roadway for motor vehicle traffic with vehicle access limited to portals, regardless of type of structure or method of construction, that requires, based on the owner's determination, special design considerations that may include lighting, ventilation, fire protection systems, and emergency egress capacity.

1.5.2 Miscellaneous Structures Not Covered by This Manual

Other miscellaneous structures such as utility bridges, conveyor belts, pipelines, and traffic signal structures are not considered to be bridges. Provisions solely for inspections of such miscellaneous structures are not included herein. For a list of structures covered by the provisions of this manual see IP 1.2.

1.5.3 Highways (Public Roads)

A highway is a publicly maintained roadway open to the public for the purposes of motor vehicle traffic. A highway is publicly ordained as such through State statute or local ordinance. The term "public road" may be used interchangeably with the term "highways."

Interpretations of this definition include:

- The following are considered highways or public roads:
  - All State Routes
  - Local roads and streets on the inventory of routes receiving Liquid Fuels Tax allocations
  - All highways open to public vehicular traffic in State parks, forests, etc., even if public access is seasonal
  - Portions of the PA Turnpike system open to public vehicular traffic
- The following are not considered public roads:
  - Privately-owned driveways open to public vehicular traffic
  - Service roads in State parks, etc., not open to public vehicular traffic
  - Ramps and roadways open to the public but not ordained through statute or local ordinance
  - Routes limited to pedestrians, bicycles, snowmobiles, maintenance vehicles and/or emergency vehicles and not open to public vehicular traffic

1.5.4 Public Road Bridges

A public road bridge is defined as a bridge carrying a highway. Bridges carrying roads open only to public transit busses also qualify as public road bridges.

In cases where there is conflict or question, the Bridge Inspection Section Chief shall make the determination whether or not a bridge route meets the definition of a public road. The District will prepare background information for this determination.

1.5.5 Highway Bridges

Highway bridges are those that carry highways or public roads.

1.5.6 Non-Highway Bridges and Structures

Non-highway bridges are bridges that are maintained on non-highways for the purpose of carrying motor vehicles (e.g., haul road vehicles, private drives) and/or non-motor vehicle traffic (e.g., pedestrians, bicycles, snowmobiles). Non-highway bridges also include:

- Bridges carrying non-publicly owned roads open to motor vehicle traffic
- Bridges that are normally restricted to pedestrian/trail use, but may carry occasional motor vehicles only for maintenance purposes or for emergency access (e.g., fire trucks, ambulances)
- Bridges that carry railroads over highways

Non-highway structures are highway-related structures (not bridges, or culverts or tunnels) such as retaining walls, noise walls, high mast lighting, etc. and include those that carry facilities (e.g., pipelines, sign structures) over highways or other features. (Note: Structures such as pipe lines, sign structures, and conveyor systems, even if located over a highway, are not considered to be bridges since they do not carry moving loads (vehicles or trains)).

1.5.7 Bridge Categories by Length

The general definition of a bridge in IP 1.5.1 does not depend upon its length. However, the bridge length defines many legal inspection requirements, program applicability, and funding eligibility.

1.5.7.1 STRUCTURE LENGTH AND METHOD OF MEASUREMENT

The Structure Length, as defined by the FHWA Structure Inventory and Appraisal (SI&A) Coding Guide and as recorded in BMS2 Item 5B18, is the overall length measured along the centerline of roadway from paving notch to paving notch or back-to-back of backwalls of abutments, if present. Otherwise, the Structure Length is measured from end-to-end of the bridge deck, but in no case less than the bridge opening length.

Measure culverts, arches and pipes between the inside faces of walls along the centerline of the roadway regardless of their depth below grade.

- If there are multiple culverts or pipes and the clear distance between multiple openings is less than half that of the smaller contiguous opening, the measurement is to be between the inside faces of the exterior culverts or pipes.
- For pipes and arches where the measurement is to be taken between the inside faces, measure the length at the height of the springline.
- If the culvert or arch is at grade, measure the length from paving notch to paving notch if any, or back-to-back of exterior walls along the centerline of roadway.

If the structure is a highway tunnel, measure the Structural Length of the tunnel along the centerline of the roadway. For examples of measuring lengths of bridges, see the sketches in the instructions for BMS2 item 5B18 Structure Length in the BMS2 Coding Manual, Pub. 100A.

1.5.7.2 BRIDGE OPENING AND METHOD OF MEASUREMENT

The Bridge Opening, as defined by the FHWA SI&A Coding Guide, is the length measured along the centerline of roadway between front faces of abutment stems, between inside faces of culverts and springlines of arches and pipes.

- If there are multiple culverts or pipes and the clear distance between multiple openings is less than half that of the smaller contiguous opening, the measurement is to be between the inside faces of the exterior culverts or pipes.
- If there are multiple arches, the measurement is to be between the inside faces of the exterior arches measured at the springline.

When underpinning or facing has been added to the bridge substructure, it should not be considered in the opening length measurement unless it extends the full height of the abutment.

For additional examples of measuring bridge openings, see the sketches in the instructions for BMS2 item 5E01 NBIS Bridge Length in the BMS2 Coding Manual, Pub. 100A.

1.5.7.3 NBIS BRIDGES

In order to be under the jurisdiction of the NBIS, and part of the NBI, the bridge must be a highway bridge and its bridge opening must be greater than 20’, measured along the centerline of roadway. The BMS2 Item 5E01 NBIS Bridge Length is provided to record whether the bridge meets the minimum opening specified for NBIS as per IP 1.5.7.2. NBIS bridges must be coded: BMS2 Item 5E01 = Y (for Yes)

1.5.7.4 OTHER BRIDGES (8’-20’ LENGTH)

Bridges with openings less than the NBIS length are not governed by the NBIS and therefore there are no statutory requirements for their inventory and inspection.

Bridges in the 8’-20’ range may behave in a similar manner to those meeting the NBIS length definition and can present significant risks to public safety. Moreover, these bridges may represent a large portion of the infrastructure that owners have to maintain.

Best Business Practice:

- Inventory and inspect 8’ – 20’ bridges at the same level of scrutiny as NBIS-length bridges.
- Maintain these bridge records in BMS2 for further analysis and as the base information for asset management.

The Department requires that all PennDOT-owned bridges in the 8’ to 20’ range be inventoried in BMS2 and inspected in conformance with the criteria outlined in Table IP 2.3.2.4-1.

1.5.7.5 MINOR BRIDGES (LENGTH < 8')

Minor bridges (or culverts) less than 8' in length are a lesser concern because the risks to public safety are generally significantly lower than for larger bridges. However, minor non-culvert structures with separate bridge superstructures can be very sensitive to heavy axles and should be load rated for posting and safety.

Owners may elect to use BMS2 to maintain inventory and inspection data for these structures. The Department prefers that minor structures less than 6' in length be inventoried elsewhere.

1.5.7.6 NTIS TUNNELS

All structures defined as highway tunnels (see IP 1.5.1 for definition) on all public roads, on and off Federal-Aid highways shall be included under the jurisdiction of NTIS and shall be inspected in accordance with the TOMIE Manual.

1.5.8 Inspection

For the purposes of this Manual, the term "inspection" encompasses all activities needed to determine and record the required inventory, condition, and appraisal items, including the structural analysis and rating. The term "field inspection" will be used when relating to the investigations at the site only.

1.6 PERTINENT STATUTES REGARDING BRIDGE INSPECTION

While bridge inspection is necessary for assurance of public safety, there are several statutes governing this activity. Some of the more critical statutes, but not all, are referenced in this section.

1.6.1 Federal Regulations

1.6.1.1 NATIONAL BRIDGE INSPECTION STANDARDS (NBIS)

Initially adopted in 1970 following the infamous collapse of the Silver Bridge in West Virginia, the NBIS is the backbone of the inspection-related statutes. The 2005 NBIS mandates that inspections be performed and sets the applicable inspection and data reporting standards. The 2005 NBIS (including 2009 modifications) is contained in the CFR Title 23 Highways – Part 650, subpart C.

The NBIS addresses the following:

- Purpose. (§650.301)
- Applicability. (§650.303)
- Definitions. (§650.305)
- Bridge inspection organization. (§650.307)
- Qualifications of personnel. (§650.309)
- Inspection frequency. (§650.311)
- Inspection procedures. (§650.313)
- Inventory. (§650.315)
- Reference manuals. (§650.317)

The requirements of the NBIS have been incorporated into this Manual. A copy of the NBIS is contained in Appendix IP 01-B.

1.6.1.2 NATIONAL TUNNEL INSPECTION STANDARDS (NTIS)

The NTIS were established in 2015 and are contained in the CFR Title 23 Highways – Part 650, subpart E.

The NTIS addresses the following:

- Purpose. (§650.501)
- Applicability. (§650.503)

- Definitions. (§650.505)
- Tunnel inspection organization responsibilities. (§650.507)
- Qualifications of personnel. (§650.509)
- Inspection interval. (§650.511)
- Inspection procedures. (§650.513)
- Inventory. (§650.515)
- Incorporation by reference. (§650.517)

The requirements of the NTIS have been incorporated into this Manual. A copy of the NTIS is contained in Appendix IP 01-C.

1.6.2 Pennsylvania Consolidated Statutes TITLE 75 VEHICLES (Vehicle Code)

Title 75 contains the statutes for the use of PA State and local highways by vehicles. Most pertinent to bridge safety and an inspection is:

- Chapter 49 Size, Weight and Load
  The scope of this Chapter is to regulate vehicle size/weight and authorize restrictions to be placed on roads and bridges (i.e., weight postings).

  No vehicle, combination or load which has size or weight exceeding the limitations provided in this chapter and no vehicle, combination or load which is not so constructed or equipped as required in this title or the regulations of the Department shall be operated or moved upon any highway of this Commonwealth, unless permitted as provided in this title by the Department or local authority with respect to highways and bridges under their respective jurisdictions.

1.6.3 Pennsylvania Statute - Act 44 of 1988

Act 44 of 1988 (71 P.S. §512(a)(19)) gives the Department the power and duty to compile, maintain and forward to FHWA the required information for public road bridges greater than 20' in length [NBIS bridges]. Act 44 imposes additional powers and duties upon the Department of Transportation relating to the inspection of bridges without regard to ownership. Act 44 empowers the Department to inspect those bridges owned by counties and municipalities that have not been inspected in accordance with NBIS.

According to the Department's interpretation, Act 44 of 1988 directs the Department to inspect the municipality or county owned bridges if the owner:

- Refuses/is unable to inspect their bridges
- Refuses/is unable to inspect the bridges in a timely manner
- Elects to have the Department inspect the bridge on their behalf

Act 44 of 1988 also authorizes and directs the Department to post the bridges with the required information (e.g., weight restrictions, closures) in a similar fashion as the inspections.

Act 44 of 1988 also authorizes (in 71 P.S. §511.5) the Department to collect from the municipality's Liquid Fuels allocation that share of the cost of the Department-directed inspections and postings that were not reimbursed by the FHWA.

1.6.4 PA Code Statutes TITLE 66 PUBLIC UTILITIES

Sections 2702 and 2704 of Title 66 establish the exclusive jurisdiction of the PA Public Utility Commission (PUC) over all parties (i.e., the Department, railroads, municipalities, utilities) at public crossings. This overarching authority balances and resolves any potential conflicting public interests within our highway right-of-ways where a highway and a railroad intersect at-grade or cross over or under. Highway-railroad grade separation bridges are considered to be rail-highway crossings subject to the PUC.

Through its official and legally enforceable Orders/Secretarial Letters, the PUC assigns various maintenance responsibilities to the involved parties at each individual bridge. These responsibilities may include performing and/or payment for: structure repair/rehabilitation/replacement, bridge inspection, weight/vertical clearance postings, track maintenance, highway maintenance, etc.

The District Grade Crossing Unit is the responsible organization for the liaison between the PUC, railroads, and other interested parties at any rail-highway crossing structure involving State Routes. The Grade Crossing Unit in the Bureau of Project Delivery assists the Districts in District and statewide PUC issues.

1.6.5 PA Code TITLE 67 TRANSPORTATION

TITLE 67 TRANSPORTATION sets forth the Department regulations governing transportation issues. The following sections are most critical to bridge inspection and management:

- Chapter 179 Oversize and Overweight Loads and Vehicles
  This Chapter regulates the use of State highways for the purpose of moving mobile homes, oversize or overweight vehicles, and combinations of vehicles, including the loads carried thereon, in order to preserve the safety of the users of Commonwealth highways; to facilitate the movement of mobile homes, oversize or overweight vehicles, and combinations of vehicles, as well as the movement of traffic, generally; to protect the structural integrity of the highway and bridge system; and to encourage the economic growth of commerce and industry in the Commonwealth without the necessity of constant supervision by Department employees, police and local officials. Nothing contained in this chapter is intended to relax existing safety requirements.

- Chapter 185 Axle Weight Table
  This chapter provides a table applying the formula in TITLE 75 VEHICLES § 4943(b)(1)(also known as the "Bridge Formula") to the various numbers, weights and spacings of axles found on combinations registered in PA that weigh in excess of 73,280 pounds.

- Chapter 191 Authorization to Use Bridges Posted Due to Condition of Bridge
  This chapter regulates the use of bridges posted under 75 Pa. C.S. § 4902(a) (relating to restrictions on use of highways and bridges) by vehicles or combinations having a gross weight in excess of the posted weight limit or a physical dimension in excess of the posted size restriction.

- Chapter 212 Official Traffic-Control Devices
  The purpose of this chapter is to establish required study procedures and warrants for the establishment, revision and removal of restrictions on all public highways within this Commonwealth, whether by the Department on State-designated highways or by local authorities on any highway within their physical boundaries.

Further attention is drawn to critical subsections of this Chapter:

- § 212.117 (a) Weight Restriction based on condition of bridge
- § 212.117 (b) Weight Restriction based on condition of highway
- § 212.117 (c) Size Restriction based on condition of bridge or highway
- § 212.117 (d) Weight and Size Restrictions based on traffic conditions

1.7 RESPONSIBILITIES FOR BRIDGE SAFETY INSPECTION

1.7.1 General Inspection Responsibilities

1.7.1.1 BRIDGE OWNER RESPONSIBILITIES

In this context, the term "bridge owner" applies to the party with overall maintenance responsibility for the bridge or structure. Thus, bridge owners may include the Department, counties, municipalities other than counties, other State, local and federal agencies, multi-party owners, parties assigned maintenance responsibilities by PUC, private parties/companies, etc.

The bridge owner has an overall obligation to ensure that its structure does not present an unacceptable safety risk to the public. In PA, the acceptable level of safety is defined by Department standards as presented or referenced in this Manual. Owner must perform restoration or repair activities or take other actions (i.e., closing or removal) to ensure public safety. In order to satisfactorily demonstrate that a structure is safe, safety inspections by the owner are best practice and, in some cases, prescribed by law and Department regulations.

The responsibilities of the bridge owner are further delineated for each type of bridge in the following sections.

1.7.1.2 DEPARTMENT RESPONSIBILITIES

In addition to its responsibilities as a bridge owner for its many bridges and structures, the Department has federal and State statutory responsibilities for the safety and inspections of public road bridges in PA owned by others. Some of the more critical of these responsibilities include assurance of NBIS/NTIS compliance, proper bridge restrictions for vehicle size and weight, administration of federal monies for NBIS/NTIS inspection and the reporting of NBI/NTI bridge data to FHWA. In addition to public road bridges, the safety of non-highway bridges and structures over State Routes is a Department responsibility.

The responsibilities of the Department are further delineated for each type of bridge in the following sections.

1.7.2 Highway Bridge & Tunnel Inspection Responsibilities

1.7.2.1 OWNER RESPONSIBILITIES FOR HIGHWAY BRIDGES

For NBIS/NTIS highway bridges, the owner responsibilities include:

- Inspection of the bridge in accordance with the NBIS/NTIS and Department standards
- Reporting of bridge inventory and condition information, as well as critical findings and follow-up actions to the Department in accordance with Department standards and in a timely manner
- Installation and maintenance of proper bridge restriction signing for vehicle weight and size, including barricades for closed bridges.
- Maintenance of bridge inventory and inspection records
- Payment for any portion of the bridge inspection costs not included in the federal reimbursement program as administered by the Department

DEPARTMENT HIGHWAY BRIDGES: The Districts are responsible to perform and manage the safety inspections of the Department bridges in their jurisdiction, including Department owned non-NBIS length bridges (8’-20’ length). The District may elect to inspect their bridges in house or hire a consultant to perform the work. If performing the inspections in house, the District shall have sufficient staff with proper training and available equipment.

LOCALLY OWNED HIGHWAY BRIDGES: The local bridge owner is responsible to perform and manage the safety inspections of all NBIS/NTIS bridges in their jurisdiction. The inspection teams may be from their in-house staff or from consultants, but they must meet NBIS or NTIS qualifications as required, see IP 2.1.3. Locals may also use consultants provided by the Department’s open-end agreements or may use an umbrella agency (e.g., a County-wide contract for township bridges).

TURNPIKE HIGHWAY BRIDGES: The Pennsylvania Turnpike Commission (PTC) is responsible for the inventory and inspection of the NBIS/NTIS bridges under their jurisdiction. The PTC will maintain the inventory and inspection data in the Department’s BMS2 in a timely manner through their remote terminals. The Department and BIS will provide technical guidance and assistance for all activities related to the inspection program.

DCNR HIGHWAY BRIDGES: The Department of Conservation and Natural Resources (DCNR) is responsible for the inventory and inspection of all NBIS/NTIS bridges in their jurisdiction. The DCNR will maintain the inventory and inspection data in the Department’s BMS2 in a timely manner through their remote terminals. The Department and BIS will provide assistance for all activities related to the inspection program.

OTHER STATE AGENCY HIGHWAY BRIDGES: Other State agencies that own NBIS/NTIS public road bridges are required to inspect their bridges or to contract with another agency to do so. The Department and BIS will provide assistance and coordinate all activities related to the inspection program

FEDERAL LAND HIGHWAY BRIDGES: For Federal Land bridges in PA, the Eastern Federal Lands Highway Division of FHWA is responsible for their inspection and NBI/NTI reporting. Send any questions about those bridges to BIS and they will be forwarded to the FHWA.

HIGHWAY BRIDGES UNDER PUC JURISDICTION: Highway bridges (>20' in length) under PUC jurisdiction carrying public roads over a railroad must meet the same inventory and inspection requirements of NBIS and the Department standards as other highway bridges. Non-NBIS highways less than 20' length carrying State Routes over a railroad are to be inspected to Department standards also.

For highway bridges over railroads under the jurisdiction of the PUC, the term "owner" is not entirely applicable because the PUC has the sole authority to assign "maintenance responsibilities" (including inspection responsibilities) for all or portions of the bridge through a PUC Order that is legally enforceable on all involved parties. The District Grade Crossing Engineer/Administrator should seek to have the PUC Orders clearly identify the party responsible for performing and reporting inspections and for the authority to approve the use of the bridge by hauling permit vehicles (see IP 10.3). For the PUC proceedings concerning determination of inspection, maintenance, and permit approval responsibilities, the Department would normally make the following arguments:

- The public agency that has administrative jurisdiction over the Public Road involved has a responsibility to the users of its highway to ensure their safety and should take the lead in resolving and inspecting the bridge.
- The party assigned maintenance responsibilities should also be responsible for the inspection duties.
- The party assigned maintenance and inspection responsibilities should be given the authority to approve hauling permits.
- For bridges not involving State Routes, the Department's participation should be limited to reporting required NBIS data to the FHWA.

For highway bridges over railroads under PUC jurisdiction, the District Grade Crossing Engineer/Administrator (E/A) must work closely with the District Bridge Engineer to ensure that all technical, safety, and administrative issues are resolved. The Grade Crossing E/A is to do the coordination and administrative tasks, while the District Bridge Engineer is to provide technical support for the bridge related issues. This technical support includes producing written documents (e.g., inspection reports, summary letters), attending meetings and providing testimony at hearings and other legal proceedings. A qualified staff engineer may be substituted for the District Bridge Engineer, as appropriate. See other portions of IP 1.7 and IP 2.8 for further instructions on highway bridges over railroads under PUC jurisdiction. Also refer to the Department's Grade Crossing Manual, Publication 371.

HIGHWAY BRIDGE OWNERSHIP IN DISPUTE: Where the ownership of a highway bridge on a State Route is in question, the District is to submit information to enable the Office of Chief Counsel to make a determination of the Department's legal position. If the bridge is an NBIS length bridge and other parties are not fulfilling the NBIS responsibilities, the Department shall inspect the bridge through its Districts until the issue is resolved.

NON-NBIS HIGHWAY BRIDGES: For non-NBIS highway bridges (primarily those with lengths 8'-20'), the owner may elect to inspect and report the inventory and condition information to the Department for inclusion in the BMS2. Department owned bridges 8'-20' in length must be inspected and data maintained in BMS2.

1.7.2.2 DEPARTMENT RESPONSIBILITIES FOR HIGHWAY BRIDGES

The Department responsibilities include:

- Maintain an inventory of highway bridges in PA and their condition in BMS2, including:
  - All NBIS/NTIS highway bridges including those owned by locals and other agencies
  - All other highway bridges (8'-20' length) on State Routes or owned by the Department
  - All other highway bridges (8'-20' length) owned by others when requested by the owner
- Ensure compliance with NBIS/NTIS for all PA highway bridges.

- Ensure that vehicle size and weight restrictions on all bridges are in accordance with Department standards.
- Reporting NBIS/NTIS-required bridge inventory and inspection information to FHWA.
- QC/QA of bridge safety inspections.

1.7.2.3 DEPARTMENT RESPONSIBILITIES FOR PUC JURISDICTION HIGHWAY BRIDGES ON STATE ROUTES

The Department is to ensure that all highway bridges carrying State Routes under the PUC jurisdiction are inspected in accordance with NBIS and Department standards.

PUC ORDERS FOR SAFETY INSPECTION INFORMATION: In the past, the PUC has issued Orders or Secretarial Letters requiring the Department to perform new structure safety inspections to provide the needed bridge condition information to serve as the basis for its Orders regarding maintenance of the bridge for public safety. The PUC has also requested that the Department provide copies of the inspection reports to all parties in the proceeding. Please note the following:

- Because the safety inspections may identify maintenance needs for portions of the bridge for which other parties are assigned maintenance responsibility, it is appropriate that the Department share the inspection reports with those parties. These other responsible parties may include the railroad (or its successor), the local municipality, etc.
- Providing the inspection information to the PUC may be problematic if the Department's inspection information is not identified as "Not for Public Disclosure" and handled accordingly. The bridge inspection record might mistakenly become part of the public record of the PUC proceeding and then subject to improper discovery and dissemination.

In order to provide the needed information to the various parties and to ensure that the information is kept from becoming public record, the following procedures should be followed:

1. The District, through the Grade Crossing E/A, must consult with the Office of Chief Counsel (OCC) if the PUC requests such inspection data and before any inspection information is disseminated.
2. The District is to provide copies of the inspection reports to the other parties with maintenance responsibilities at the crossing. Each recipient is to be advised that the records are not for public disclosure and instructed not to allow further dissemination or copying or inclusion in the PUC staff files. Each copy distributed by the District must have the "Not for Public Disclosure" stamp affixed as per IP 1.8.3.
3. If requested by the PUC, the District is to provide a copy of the inspection report to the PUC Bureau of Transportation, Rail Safety Division on a temporary basis to allow the PUC engineers to fully understand the bridge conditions and the Department's recommendations for the structure. The cover letter to the PUC should advise the PUC that the records are not for public disclosure and instructions not to allow further dissemination or copying or inclusion in the PUC staff files. Each copy distributed must have the "Not for Public Disclosure" stamp affixed as per IP 1.8.3. The District's cover letter should specify when the report is to be returned to the Department (minimum of 30 days, maximum 90 days). In addition, counsel will seek a protective order from the judge providing that: (a) The report is kept in a sealed envelope in the hearing file clearly marked as "Not for Public Disclosure" and (b) all parties are instructed that following the use of the report in the proceeding the report is to be returned to the Department, or destroyed with an affidavit submitted to the Department that the report has been destroyed. The District must ensure the report is returned to the Department.
4. If requested by the PUC and/or approved by OCC, the District may provide a Summary Letter of the bridge conditions (as outlined in IP 1.8.2.5) to the PUC. The Department will allow this Summary Letter to be entered into the public records of the PUC proceedings. The contents of this letter should be reviewed by OCC before its release to the PUC.

PUC BRIDGES REQUIRING POSTING OR CLOSING: For those PUC jurisdiction bridges carrying State Routes over a railroad, should the condition and appraisal reveal serious deterioration that warrants posting a new bridge load limit, changing an existing posted load limit or closing the structure, the District, acting on behalf of the Department, shall immediately take appropriate action to mitigate the problem. For a bridge restriction on a route that would normally require Highway Administration approval, submit a posting authorization request as per IP 1.7.2.4 and IP 4.6.3. If need be, the District is to take any emergency actions to safeguard the public.

Concurrent notification of impending or completed action is to be sent to the PUC requesting concurrence. Such notification to the Commission will be made by the District's Grade Crossing E/A with a copy of all correspondence to the Grade Crossing Unit of the Bureau of Project Delivery. The District is to submit a letter to the PUC Bureau of Transportation and Safety, Railroad Safety Division, stating in general terms the need for establishing the bridge restriction and requesting concurrence from the PUC. The notification letter to the PUC should contain the BMS2 number (Item 5A01 SR ID) and the DOT Number (Item FR05 formerly titled AAR Number). The following public record information is to be attached to the PUC notification letter:

- Summary Letter prepared by the District Bridge Engineer stating need for the posting (see IP 1.8.2.5)

Additional inspection information is needed on a temporary basis by the PUC Rail Safety Division for their consideration of the District's posting recommendation. Because of the confidential nature of this inspection information, each of the following inspection documents must be stamped "Confidential" and noted in the letter for return within 30 days:

- Posting approval letter with completed bridge posting request form
- A copy of the inspection report
- Structural analysis of critical elements

NOTE: The Grade Crossing Unit shall be notified immediately of the date the posting or closing of the structure takes effect.

1.7.2.4 DEPARTMENT RESPONSIBILITIES FOR LOCALLY OWNED NBIS/NTIS HIGHWAY BRIDGES

For locally owned NBIS/NTIS highway bridges, the Department has additional responsibilities under the NBIS/NTIS and PA Act 44 of 1988 to ensure that bridges are properly inspected and posted for weight restrictions as needed. Those responsibilities include:

- The Districts shall notify, in writing, the local government bodies that have responsibility for bridges on the local highway system and apprise them of the NBIS/NTIS requirements.
  - The letter shall state the Department's intent to inspect bridges on behalf of the local government in the event that NBIS/NTIS inspections become past due.
  - The letter should also inform the local bridge owner that the non-reimbursable portion of the inspection will be deducted from their liquid fuels allocation.
  - The letter shall be sent annually (in January/February) to the local government bodies with an attached list of bridges with inspection due dates in the forthcoming year beginning in April.
  - The letter shall also provide an attachment of a list of bridges requiring Scour Plans of Action.
  - The letter needs to be sent to the local bridge owner with a copy to their consulting engineer, when applicable. In cases when a county-wide agreement is utilized, the umbrella planning agency should also receive a copy. Provide a copy of all letters to The District Municipal Services Unit.
  - As stated in this section under the subheading NON-COMPLIANCE WITH NBIS/NTIS (see below), the letter must notify the local government(s) sixty (60) days before the bridge inspections could become past due.
  - A sample letter is located in Appendix IP 01-D, Local NBIS Inspection Notification Letter.
- The Districts should review local inventory and inspection procedures at least once every two years. The primary objective of such reviews should be to apprise the local governments of new developments and to provide necessary guidance.
- The Districts are to monitor local compliance with NBIS/NTIS on a monthly basis.
- The Districts are to perform QC measures on local bridges to ensure that restrictions needed for public safety are in place.
- The Districts should enter into agreements with the local governments to reimburse them for NBIS/NTIS- eligible inspection costs.
  - The Districts should review the status of the agreements, paper or electronic, in conjunction with sending the Local NBIS Inspection Notification Letter to the local governments.
  - The District must initiate the process to draft, review, and execute successive agreements at least one year prior to the expiration of an existing agreement to ensure continuity between consecutive agreements.
- Under emergency conditions, the District should provide recommendations and engineering assistance

to local governments upon request. Example: Furnish the services of the "Board of Inquiry - Bridge Collapse Investigation."

- The District should not furnish services which are normally available from private sources, such as engineers or inspectors, when there is ample time to contract for the same and public safety is not in jeopardy.
- The Districts are to maintain bridge inspection files for local bridges. At a minimum, the file for each individual bridge should contain the most recent inspection report with the current analysis/rating/posting evaluation, and other important safety related pertinent correspondence (e.g., critical deficiencies, posting letters). The owner is responsible to maintain the more complete bridge file (see IP 8).
- The District should provide liaison services relating to the above matters and should make an extra effort to explain recommendations and findings to the local officials and or employees to the extent needed for them to understand the findings and recommendations and the consequences of action or inaction.

NON-COMPLIANCE WITH NBIS/NTIS: When the local governments responsible for bridge inspection cannot or will not inspect their bridges in a timely manner in accordance with NBIS/NTIS and Department standards, Act 44 of 1988 requires the Department to perform the necessary inspections. Act 44 also authorizes the Department to deduct the owner's portion of the inspection costs from that municipality's Liquid Fuel Allocation. If the bridge Owner has not taken appropriate actions (e.g., engage an engineer) in a timely manner to have a bridge inspected to meet NBIS/NTIS requirements, the District is to follow the following procedure:

1. Notify the Owner in writing of the Department's intent to have the bridge inspected and to deduct the owner's share of the inspection costs from the Owner's Liquid Fuels Allocation. Appendix IP 01-D, Local NBIS Inspection Notification Letter, should be sent each year that the owner has bridge inspections due. The letter must be received sixty (60) days before the bridge inspection past due date.
2. Contract for consultant engineering services through a District or Statewide inspection agreement.
3. Have the consultant perform the inspection within thirty (30) days from the past due date and report findings to the bridge owner.
4. Deduct the owner's share of the inspection cost from its Liquid Fuels Allocation.

DEPARTMENT RESPONSIBILITIES FOR PUC JURISDICTION HIGHWAY BRIDGES ON LOCAL ROUTES: The Department's responsibilities for these NBIS bridges are similar to other bridges owned by the counties and municipalities, as listed previously in this section. The party to whom the PUC assigns responsibility for the maintenance of the bridge should also be tasked with the safety inspection. The Department can work with that party to ensure compliance with NBIS. If the Department's consultant prepares an inspection report on behalf of one of the parties, the District should not disseminate copies to other parties.

HIGHWAY BRIDGES OF UNKNOWN OR DISPUTED OWNERSHIP ON LOCAL ROADS: When the ownership of an NBIS highway bridge is unknown or in dispute, the Districts should act as mediators to assist in reaching agreement for the inspection responsibilities. The public agency that has administrative jurisdiction over the Public Road carried has perhaps the largest responsibility to the users of its road to ensure their safety and should take the lead in resolving which party will inspect the bridge. If the bridge is an NBIS length bridge and other parties are not fulfilling the NBIS responsibilities, the Department shall inspect the bridge through its Districts until the issue is resolved to ensure public safety.

HIGHWAY BRIDGES REQUIRING POSTING OR CLOSING: When it has been determined that an NBIS/NTIS bridge is not safe to remain open at the currently posted weight restriction and the local owner cannot or will not take the necessary actions to ensure public safety, Act 44 of 1988 authorizes and directs the Department to place required restrictions on that bridge. The Districts must take a proactive stance to resolve unsafe local bridges expeditiously. The Districts are to use the following procedure:

1. The District is to inform the local owner immediately of the concerns for the safety of the bridge. The initial contact may be by telephone or in person, but must be immediately followed by a letter, signed by a staff Professional Engineer (preferably the District Executive or the District Bridge Engineer) informing the owner of the bridge condition and its responsibility for public safety. Inclusion of inspection reports or reference thereto will be more compelling. Immediate delivery of the letter (facsimile is acceptable) is recommended. Forward a copy of that letter and other supporting documentation to the Bridge Inspection Section Chief.

2. If the owner indicates its unwillingness or inability to take appropriate actions, the District should immediately inform the Bridge Inspection Section Chief of the situation and prepare plans for the Department to take necessary actions. These plans may include posting or closing the bridge until further studies can determine its safety or until repairs by the owner can be implemented. The Bridge Inspection Section Chief will coordinate approval of this plan with the Director, BOMO and the Deputy Secretary for Highway Administration.
3. The Deputy Secretary for Highway Administration will authorize the District to proceed with its plans to restrict the bridge.
4. The District shall maintain records of associated costs for initial, revised and maintenance of existing postings and 100% of those costs will be deducted from the Liquid Fuels Allocation for the bridge owner.

DEPARTMENT ENGINEERING CONSULTANT AGREEMENTS FOR LOCAL BRIDGE INSPECTION: In order to have resources available to locals to ensure NBIS/NTIS compliance for all PA bridges or to perform emergency inspections, the Department will maintain open-end engineering consultant agreements for bridge inspection services and make them available to local owners (see IP 1.10.3). BIS will maintain a statewide agreement available to all Districts. The Districts should consider having similar District-wide agreements if the projected need is present.

1.7.3 Inspection of Non-Highway Bridges and Miscellaneous Structures Over State Routes

1.7.3.1 GENERAL DISCUSSION

Where a non-highway facility (a bike/pedestrian pathway, utilities, sign structure, etc.) exists over a Public Road, the bridge/structure needs to be inventoried only to be in compliance with NBIS. The NBIS does not require a structural safety inspection as it does for highway bridges. However, the Public Road owner may elect to require the bridge owner to perform a structural inspection as part of the occupancy agreement that permits the bridge or structure to be built and/or maintained over its Right-of-Way.

As part of its responsibilities as steward of its facilities, the Department is to verify and ensure public safety of non-highway bridges over State Routes by requiring the bridges to be inspected by the owner through formal legal agreements such as PUC Orders, Highway Occupancy Permits (HOP), or Highway Occupancy Agreements (HOA). The scope of such non-highway bridge inspections may be tailored to the subject bridge. Federal bridge inspection monies are available only for the inventory, not inspection of these bridges over Public Roads.

There are three basic situations where non-highway bridges or structures cross over State Routes, each with a different method of specifying bridge safety inspection requirements:

1. <u>Rail bridges over State Routes</u>:
   - Title 66 and the Public Utility Commission Orders (PUC) govern the crossing.
   - Inspection requirements: See IP 1.7.3.4 entitled Responsibilities for Railroad Bridges Over State Routes.
2. <u>Non-highway utility structures over State Routes</u>:
   - Example: standalone utility pipeline structures
   - Inspection requirements: To be included in Highway Occupancy Permit (HOP)
3. <u>For other, non-utility, non-highway bridges/structures</u>:
   - Examples: pedestrian/trail bridges, building passageways, sign structures, privately-owned driveway bridges
   - Inspection requirements: The Highway Occupancy Agreement (HOA) for the site must include the specific requirements for the inspection of the overhead bridge/structure. The General Scope of Work for Safety Inspection of State and Local Bridges shall be followed for inspection of these structures (see Appendix IP 01-F). Since these structures are not reported to the NBI, they require less inventory information to be collected (see Appendix IP 01-I).

1.7.3.2 DEPARTMENT RESPONSIBILITIES FOR NON-HIGHWAY BRIDGES/STRUCTURES OVER STATE ROUTES

The Department is to ensure that non-railroad bridges or structures maintained over State Routes do not pose an unacceptable risk to public safety. In order to do so, all such structures must be inventoried and inspected. The District's responsibilities for the inventory and inspection of bridges over State Routes are as follows:

1. Inventory of Bridge Information
    a. Maintain required inventory data in BMS2.
    b. Maintain a permanent file of inventory and inspection information on the bridge.
    c. Maintain all information and APRAS data needed for permit routing on the State Route. Measure or verify all vertical and horizontal clearances associated with the State Route on a frequency not to exceed 24 months.
    d. Provide a copy of specific maintenance needs and other relevant findings to the bridge owner after each inspection of a bridge site and/or update of BMS2 data.

2. Inspection of Bridge Site
    a. Inspect the highway environs portion of the bridge site on a 24-month frequency for deficiencies. Record highway-related maintenance needs such as: Signing, drainage, pavement, guide rail, etc.
    b. Observe the overall condition of the bridge from the highway. Inform the bridge owner in writing of any deficiencies noted that present safety and/or maintenance problems.
    c. Maintain a permanent file of information on the bridge. Maintain all information and APRAS data needed for hauling permit review and approval.
    d. Inspect any Department-owned signing and supports for deficiencies.
    e. In BMS2, set BMS2 Item 7A03 Type of Inspection = H (for Highway Environs only) for inventory update/bridge site inspection to differentiate it from the safety inspection performed by the owner.

3. Review and Acceptance of Owner's Bridge/Structure Inspection Report
    a. Ensure that there is in place a legal agreement (i.e., PUC Order, HOA, or HOP, etc.) between the Department and the bridge owner concerning the requirements for safety inspection.
    b. Ensure compliance of owner with inspection scope and frequency.
    c. Provide Quality Control (QC) review of the Bridge Inspection Report, including load ratings.
    d. Maintain inspection data in BMS2. Provide the bridge owner with a copy of updated BMS2 printouts.
    e. In BMS2, set BMS2 Item 7A03 Type of Inspection = O for safety inspection by owner.

NON-HIGHWAY BRIDGES OVER STATE ROUTES WITHOUT AN HOA OR HOP: There may be existing bridges or structures over State Routes that were previously allowed under a now non-standard agreement or without any formal agreement. New HOPs or HOAs shall include inspection requirements which are to be implemented at each site to bring uniformity to these non-highway bridges over State Routes. It is recommended that existing HOPs and HOAs with no inspection requirements be amended to include this requirement when possible.

BRIDGE DEFICIENCIES: Bridge or structure deficiencies are the responsibility of the owner. When critical deficiencies are found, the District must take a proactive stance to inform the owner of the Department's concerns and to ensure that the owner takes proper action to ensure public safety. The initial contact may be by telephone or in person, but must be immediately followed by a letter, signed by a staff Professional Engineer (preferably the District Executive or the District Bridge Engineer) informing the owner of the bridge condition and the owner's responsibility for public safety. This notification letter may include field views or inspection reports produced by the Department or consultants (or portions thereof), but the Districts must take care to protect the confidential nature of such information. See IP 1.8 for discussion of the procedures to be used when such sensitive information is to be shared. Immediate delivery of the letter (facsimile is acceptable) is recommended. Forward a copy of the bridge deficiency notification letter, and other supporting documentation, to the Bridge Inspection Section Chief.

1.7.3.3 OWNER RESPONSIBILITIES FOR NON-HIGHWAY BRIDGES/STRUCTURES OVER STATE ROUTES

The owner is responsible to maintain the bridge or structure in a condition as to not pose a threat to the public safety. The owner also has an obligation to demonstrate the safety of that structure to the public whose property the structure crosses. Accordingly, the owner must inventory and inspect the bridge and report the findings in a manner as directed by the legal agreement governing the crossing.

The Department policy for bridges and structures over State Routes is to assign the following inventory and inspection responsibilities to the owner of the overhead facility through the HOA, HOP, or PUC process:

1. Inventory
   a. Maintain permanent file of bridge/structure records as described in IP 8.
   b. Provide one copy of structure plans to the District for their records.
2. Inspection
   a. Inspect the bridge, load rate if required, and prepare a bridge inspection report in accordance with Department standards and requirements of the HOA/HOP, including:
      (1) Report all maintenance needs as per the BMS2 IM item screens
      (2) Report all completed maintenance or repairs.
      (3) Submit a copy of the Report to the District Bridge Engineer for review and acceptance.

For bridges under the jurisdiction of the PUC, the term "owner" is not applicable because the PUC has the sole authority to assign or re-assign "maintenance responsibilities" for all or portions of the bridge in an Order which is legally binding to all involved parties. The responsibility for bridge inspection should be outlined in the PUC Order. See IP 1.7.3.4 for further instructions on railroad bridges under PUC jurisdiction.

1.7.3.4 RESPONSIBILITIES FOR RAILROAD BRIDGES OVER STATE ROUTES

This policy applies at all railroad bridge crossings over State Routes under the jurisdiction of the PUC, regardless of the status of the railroad. This may include operating railroads, former railroad company no longer operating as a railroad but possessing abandoned railroad facilities, an abandoned railroad owned by any individual or corporation purchased from a former railroad company, or a railroad being subsidized by the Commonwealth and/or Federal Government.

When a bridge carries a railroad over a highway, the PUC has jurisdiction over the rail highway crossing until the crossing is officially abolished through a formal PUC proceeding. Because of bankruptcy and reorganization of many railroad companies throughout the Commonwealth, the responsibility for inspection and/or maintenance for many of these railroad structures crossing highways is in question. Without ongoing surveillance, public safety may be in jeopardy. Where such structures are situated on right-of-way of non-operating railroads, the PUC retains jurisdiction over the highway-railroad crossing until it is formally abolished by an Order/ Secretarial Letter of the Commission, even though the Commission's jurisdiction over the non-operating railroads or their successor companies is not clear. Highway-railroad crossing structures with ownership, inspection and/or maintenance responsibilities in question do not serve the best interest of public safety and convenience.

The Department must be proactive to ensure all railroad bridges over State Routes are properly inspected. However, for rail-highway crossings under the jurisdiction of the PUC, the Department cannot unilaterally impose new bridge inspection requirements on the railroad or any other party.

For railroad bridges over highways, the PUC would normally assign maintenance responsibilities to the railroad. Because a good maintenance program would normally begin with a review of the infrastructure conditions, bridge inspections should have already been completed for that purpose. The CFR Title 49, Part 237, dated October 1, 2019, also provides requirements and guidance for railroad bridge inspection. Since it is reasonable to assume the railroads inspect their bridges for safety and/or maintenance, providing the Department with a portion of that inspection information should not be overly burdensome to them.

The District Grade Crossing E/A, with the assistance of the District Bridge Engineer, is to first ask the railroads to provide this safety inspection information through the statewide cooperation agreements between the Department and railroads. If the railroads are not responsive, petition the PUC to require the railroads to inspect those bridges over State Routes and report the findings to BIS on a regular basis.

PUC REQUESTS FOR NEW SAFETY INSPECTIONS: In the past, the PUC has issued Orders or Secretarial Letters for the Department to perform new structure safety inspections and to provide copies of the inspection reports to all parties in the proceeding. These PUC requests pose many of the same issues raised in IP 1.7.2.3. The District, through the Grade Crossing E/A, must consult with the OCC if the PUC requests such inspection data.

In order to ensure the needed information is provided to the various parties and to ensure that the records are not for public disclosure, the following procedures should be followed:

1. The District, through the Grade Crossing E/A, must consult with the OCC if the PUC requests such inspection data and before inspections are performed and any information is disseminated.
2. SAFETY INSPECTION
   - The Department should agree to perform the inspections (by its own forces or by consultant) for the highway environs only of structures carrying railroads over State Routes, as required in IP 1.7.3.2.
   - It is the Department's opinion that the structure portion of the non-highway bridge should be inspected by the primary user on a regular basis similar to the provisions of IP 1.7.3.2. The District is to request that the Department receive any inspections made by other parties.
   - For highway-railroad crossing structures at locally owned roads, the Department should recommend that PUC assign the safety inspection of the structure and of the highway environs to the more appropriate parties involved at the crossing. The Department's role should be limited.
3. The District is to provide copies of the inspection reports to the other parties with maintenance responsibilities at the crossing. Each recipient is to be advised that the records are not for public disclosure and instructed not to allow further dissemination or copying or inclusion in the PUC staff files. Each copy distributed by the District must have the "Not for Public Disclosure" stamp affixed as per IP 1.8.3.
4. If requested by the PUC, the District is to provide a copy of the inspection report to the PUC Bureau of Transportation, Rail Safety Division on a temporary basis to allow the PUC engineers to fully understand the bridge conditions and the Department's recommendations for the structure. The cover letter to the PUC should advise the PUC that the records are not for public disclosure and instructions not to allow further dissemination or copying or inclusion in the PUC staff files. Each copy distributed must have the "Not for Public Disclosure" stamp affixed as per IP 1.8.3. The District's cover letter should specify when the report is to be returned to the Department (minimum of 30 days, maximum 90 days). In addition, counsel will seek a protective order from the judge providing that: (a) The report is kept in a sealed envelope in the hearing file clearly marked as "Not for Public Disclosure" and (b) all parties are instructed that following the use of the report in the proceeding the report is to be returned to the Department or destroyed with an affidavit submitted to the Department that the report has been destroyed. The District must ensure the report is returned to the Department.
5. If requested by the PUC and/or approved by OCC, the District may provide a Summary Letter of the bridge conditions (as outlined in IP 1.8.2.5) of the portions it inspected to the PUC. The Department will allow this Summary Letter to be entered into the public records of the PUC proceedings. The contents of this letter should be reviewed by OCC before its release to the PUC.

Because the bridge carrying a railroad over the highway is not an NBIS bridge, Federal reimbursement of inspection costs is not available. For non-NBIS structures, all of the inspection costs should be borne by the structure owner or party responsible for maintenance of the structure. PennDOT will cover the cost of the highway environs inspection of these structures.

BMS2 INVENTORY and INSPECTION DATA: To provide reasonable assurance that public safety is not jeopardized, a proper inventory and inspection would require the BMS2 information outlined in Table IP 1.7.3.4-1.

DEPARTMENT RESPONSE TO DANGEROUS BRIDGE CONDITIONS: For those structures carrying railroads over State Designated Highways, should any dangerous conditions (which would jeopardize highway or railroad traffic) be noted, the District Grade Crossing Unit shall immediately notify the railroad, the Grade Crossing Unit of the Bureau of Project Delivery and the PUC. If the situation is urgent, the District should first take proactive steps to ensure public safety and contact the PUC as time permits.

Table IP 1.7.3.4-1 Inventory and Inspection Data for Railroad Bridges over State Routes

BMS2 Input Forms	Inventory and Inspection Information Required
D-491 5A/6A/VM	Items 5A01, 6A06, VM05, 5A15, 5A21, VM02, VM03, VM04, 5A17 and 5A18
D-491 4A/5A/5B/5C/6C/FR	Items 4A19, 4A20, 5A07, 5A19, 5B09, 5C01, 5C03-5C06, 5C10-5C11, 5C14, 5C22, 5C28-5C29, 5C33, 6C05, 6C18-6C23, 6C25-6C26, 6C34, FR03-FR06, FR07, FR10-FR15
D-491 5B/5E/6A/VD	Items 5E04, 6A26-6A29, 5E01, 5B11, 5B14, 5B17, 5B18, and VD19 Note: 5E01 = N
D-491 4A	Item 4A01
D-491 1A//4A/4B/6B/7A/VA	Items 7A14, 7A01, 7A03, 7A05, 1A01-1A06, 6B36-6B40, 6B48 4A02, 4A08-4A11, 4B03 and VA02
D-491 IM	Items IM03-IM06, IM09, IM10, IM15A for highway related activities

NOTES:
- Items 7A01, 7A03, 7A05 and 7A14 are required for each inspection (by Department or owner)
- Items 4A01, 7A14, 7A01, 7A03, 7A05, 1A01-1A06, 6B36-6B40, 4A02, 4A08-4A11, 4B03 and VA02 are required by BMS2 editing functions.
- When Department (or highway owner) inspection is limited to highway environs (7A03 = H), the value "N" should be entered into items not rated/evaluated. Indicate on the field inspection report narrative fields if an item is not applicable or if it was not inspected. The highway owner may elect to evaluate certain items such as 4A10 Deck Geometry or 4A08 Safety Features for features related to the State Route only for their information and further evaluation.
- When Department (or highway owner) inspection is limited to highway environs (7A03 = H), the highway owner should record maintenance items for highway related activities.

1.8 RELEASE OF INVENTORY AND INSPECTION INFORMATION

1.8.1 General Discussion

1.8.1.1 APPLICATION

The policies and procedures in this section shall apply to all information collected or retained by the Department regarding the inventory and safety inspection of structures in PA including bridges, culverts, walls, sign structures and other miscellaneous types of highway-related structures. This information shall include, but not be limited to all information, documentation, drawings, computer software, ideas, and concepts in any tangible format.

1.8.1.2 RESPONSIBLE PARTIES FOR STRUCTURE INFORMATION

All requests for structure information should be referred to the responsible party:
- Statewide Structure Data:
  The Bridge Inspection Section Chief at BOMO is responsible for the dissemination of statewide structure statistics and information.
- Individual Structure or District-wide Data:
  The District Bridge Engineer is responsible for the dissemination of statistics and information regarding Department and locally owned structures, on an individual or District-wide basis.
- Other State Agency Bridges:
  The lead individual in the appropriate agency is responsible for the dissemination of statistics regarding that agency's structures.

1.8.1.3 GENERAL TYPES OF STRUCTURE INFORMATION

Inventory Type Information
Inventory type information pertains to a structure's characteristics that change only when the structure is altered in some way. General categories of inventory information include:
- General – Identification, location, owner information, detour length, etc.
- Features Intersected – Feature carried or intersected, vertical and horizontal bridge clearances, highway

network data, traffic data, railroad information, etc.

- Structure – Length, width, type of structure, span, configuration, material, foundation, structure details, etc.
- Stream and Navigation – Stream information, navigation controls, etc.
- Bridge Posting – Weight limits and associated dates, Blanket Permit Bridge Restrictions, etc.
- Utility – Occupancy information
- Proposed improvements – Information regarding planned or scheduled projects may be released if there is no conflict with other regulations.

Inspection Type Information

Inspection type information pertains to the assessment of the condition of the structure, the appraisal of its functionality and recommendations for maintenance or improvements. Load capacity analysis/ratings and assessment of scour potential are considered to be inspection information.

1.8.1.4 PERTINENT FEDERAL AND PA STATUTES

A number of statutes and regulations have been enacted regarding the release of bridge inspection records. The following list with its comments is provided for information only and may not be a complete or up-to-date listing.

Federal statutes

- Freedom of Information Act (FOIA)
  Provides for the release of public documents but applies only to federal agencies
- Code of Federal Regulations (CFR) Title 23, United States Code (U.S.C.) § 409 [23 U.S.C. §409]
  Restricts the discovery and admission of certain documents compiled or collected for the purpose of identifying and planning highway safety enhancements.

Pennsylvania statutes

- PA Right to Know Law (RTKL) [65 P.S. §67.101 et seq.]
  Provides for the release of "public records" of a state or local agency
- PA Vehicle Code, Title 75 [75 Pa. C.S. §3754(b)]
  Provides that the use of in-depth accident investigations and other safety study records and information is prohibited in any legal action or proceeding, and that information is protected from disclosure in the discovery process. Bridge inspections are considered to be one of the types of engineering and safety studies protected from disclosure.

1.8.1.5 RESPONSIBILITY FOR LEGAL INTERPRETATION

The Office of Chief Counsel (OCC) is responsible for interpretations of all pertinent statutes and regulations regarding the Right to Know Law (RTKL). Contact the Assistant Chief Counsel for the General Law Division when questions arise.

1.8.2 Requests for Release of Bridge Records

1.8.2.1 INFORMATION FOR DEPARTMENT STRUCTURES

The Department is to follow the policies set forth by the RTKL and Management Directive 205.36. Figure IP 1.8.2.1-1 shows the general process for a RTKL request. See Appendix IP 01-E for releasable inventory data.

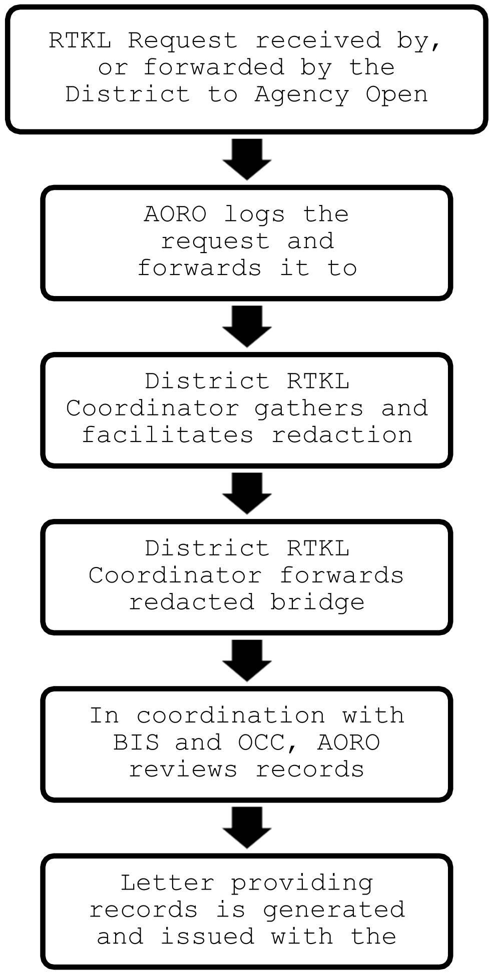

Figure IP 1.8.2.1-1 – Right –to – Know Process

1.8.2.2 INFORMATION FOR NON-DEPARTMENT STRUCTURES

Information for other PA structures is subject to disclosure. The procedure in Figure IP 1.8.2.1-1 applies to the release of that information.

1.8.2.3 REQUESTS FOR INSPECTION TYPE INFORMATION FROM COURTS OR ADMINISTRATIVE AGENCIES

For PUC requests for inspection type information, see IP 1.7.2.3 and IP 1.7.3.4.

This section applies to a request or demand for inspection related information issued by a State or Federal Court or Administrative Agency via an appropriate order or subpoena. This section does not address information requests governed under the RTKL or FOIA.

If a subpoena or other written court order is issued requesting bridge inspection information, the District is to forward the subpoena or other written court order requesting the relevant bridge information with a cover letter to:

PennDOT Office of Chief Counsel Assistant
Chief Counsel for General Law

The District is to send a copy of the information request to the Bridge Inspection Section Chief. If the District is aware that a specific attorney from either PennDOT Office of Chief Counsel or the Office of the Attorney

General is assigned to the case referenced in the subpoena or other written court order, send a copy to that lawyer also.

1.8.2.4 RECOUPMENT OF COST OF INFORMATION

The full costs of gathering and release of inventory information (including research, printing, handling and mailing) should be paid by the requestor.

1.8.2.5 SUMMARY LETTERS FOR REPORTING STRUCTURAL CONDITIONS

There are situations where the Department is warranted to provide a synopsis of pertinent structure conditions to justify an action or recommendation, including:

- Establishment of bridge weight restrictions or bridge closure
- Justification for emergency repairs
- To inform the public of the need for bridge repairs, reconstruction, or replacement
- In lieu of releasing the actual inspection report to PUC.
- Claims by the Department to recoup costs due to damage by others

Do not release the structure safety inspection report. A Summary Letter Report with a synopsis of the condition(s) of most concern should suffice for most situations.

If there is a question about the need or advisability of such a Summary Letter Report and/or its content, contact the BIS.

Guidelines for Preparation of a Summary Letter Report

The following guidance is offered for the preparation of a Summary Letter Report:

- Do not reference a specific inspection report. State that this is the current condition of the structure.
- Provide only excerpts pertinent to the information request. For example, a reply concerning a parapet collision would not warrant a discussion of waterway opening.
- Be concise and to the point.
- Do not just copy or re-type the original inspection report.
- Photos from the inspection report may be used.
- The synopsis is to be signed and sealed by the District Bridge Engineer as the Department's Professional Engineer responsible for the safety of the structures.

Special Meetings on Structure Conditions

In certain situations, it may be in the Department's best interest to discuss structure conditions with involved parties to reassure them that we are taking a proper and prudent course of action. Such situations may include: bridges with visible deterioration that causes public concern, sudden or critical bridge postings/closures, etc.

A Special Meeting, conducted by a registered Professional Engineer from the District Bridge Unit, is advised to ensure that the structure information is understood. Selected inspection documents may be viewed, but none are to be copied or released. A Summary Letter may be released.

1.8.2.6 REQUESTS FOR INSPECTION INFORMATION ON RESEARCH PROJECTS AND STUDIES

The Department may release certain inspection information research purposes and other special studies. Forward all requests for such information to the BIS for response.

1.8.3 Not for Public Record Notice and Stamp

For Department structures, place the Not for Public Record Notice shown in Figure IP 1.8.3-1 in the front of any structure safety inspection that is completed by the Department or for the Department. It may be printed on the document cover or on the face of a file folder in which the document is contained.

Not for Public Record – Structure Safety Inspection Study
This document is the property of the Commonwealth of Pennsylvania, Department of Transportation. The data and information contained herein are part of a structure safety inspection study. This safety study is only provided to those official agencies or persons who have responsibility in the highway transportation system and may only be used by such agencies or persons for safety-related planning or research. The document and information are not public pursuant to 65 P.S. §67.101 et seq., 75 Pa. C.S. §3754, and 23 U.S.C. §409 and may not be published, released or disclosed without the written permission of the PA Department of Transportation.

Figure IP 1.8.3-1 Not for Public Record Notice for Department Structures Inspection Documents

For Department structures, affix the STAMP shown in Figure IP 1.8.3-2 <u>on each page</u> of any structure safety inspection information that is released.

This document includes structure safety inspection information that is not public pursuant to 65 P.S. §67.101 et seq. , 75 Pa. C.S. §3754 and 23 U.S.C. §409 and may not be published, released or disclosed without the written permission of the PA Department of Transportation.

Figure IP 1.8.3-2 Not for Public Record Stamp for Department Structure Inspection Documents

For non-Department structures, place the Not for Public Record Notice shown in Figure IP 1.8.3-3 in the front of any structure safety inspection that is completed by the Department or its consultants for a local bridge owner. It may be printed on the document cover or on the face of a file folder in which the document is contained.

Not for Public Record – Structure Safety Inspection Study
This document is the property of the << Insert bridge owner's name>>. The data and information contained herein are part of a structure safety inspection study. This safety study is only provided to those official agencies or persons who have responsibility in the highway transportation system and may only be used by such agencies or persons for safety-related planning or research. The document and information are not public pursuant to 65 P.S. §67.101 et seq. and 23 U.S.C. §409 and may not be published, released or disclosed without the written permission of the<<Insert bridge owner's name>>.

Figure IP 1.8.3-3 Not for Public Record Notice for Non-Department Structure Inspection Documents

1.9 ELIGIBILITY OF BRIDGE INSPECTION ACTIVITY COSTS FOR FHWA REIMBURSEMENT

The Department has the responsibility and authority for the distribution of Federal highway funds in PA. The Department has determined that, in general, inspection costs for NBIS/NTIS bridges are eligible for reimbursement from federal funds. The federal reimbursement is generally limited to 80% of the eligible costs. The remaining 20% and all other non-eligible costs must be borne by the bridge owner.

To be eligible for reimbursement of these costs, the bridges must be National Bridge Inventory (NBI) bridges or National Tunnel Inventory (NTI) tunnels on public roads and not supported by tolls. See Publication 93 for approved process for selection-based criteria required for federal reimbursement eligibility. Any questions on eligibility of individual bridges, other structures or activities are to be forwarded to the BIS for resolution.

Inspection activities that are presently eligible for reimbursement are as follows:

- Bridge inspection activities including field inspections, underwater inspections, inspection reports, bridge analysis and rating, scour assessments, recommendations for repairs and improvements, testing, etc.
- Inspection of other structures including tunnels, sign structures, retaining walls and drainage structures.
- QA and QC efforts at District and BIS.

- Inspection administration activities (at BIS, District, and other owners) including scheduling, inspection agreement management, critical deficiency meetings with locals, etc.
- BMS2 activities including data entry, analysis, etc.
- Non-professional services to support NBIS/NTIS inspections such as Maintenance and Protection of Traffic rental and labor, temporary access platforms for inspection (rigging, scaffolding, etc.), access equipment rental (cranes, lifts, etc.).
- The initial inventory of bridges on public roads.
- Neither the design of repairs nor the construction of repairs are eligible for NBIS/NTIS Safety Inspection monies.

Districts are responsible to see that federal funds are being properly utilized for NBIS/NTIS bridge inspections.

Reimbursement agreements for bridge inspections between the Department and other bridge owners are to be reviewed with the above guidelines in mind. The Reimbursement Agreement System (RAS) contains the standard reimbursement agreement to be used between the Districts and Local Bridge Owners. While eligibility for reimbursement starts with approval of the Form 4232, the standard reimbursement agreement should be fully executed prior to the start of work. The standard reimbursement agreement provides NBIS/NTIS requirements that must be satisfied by the local bridge owner, default conditions, and requires Department approval of consultant agreements before start of work.

The first-time weight restriction posting of an NBI/NTI bridge is eligible for 80% federal reimbursement through a separate reimbursement agreement from the inspection agreement.

1.10 ENGINEERING AGREEMENTS FOR SAFETY INSPECTION WORK

Safety inspection work may be done by qualified in-house staff of the bridge owners or through qualified engineering consultants.

1.10.1 Applicability

Engineering agreements may be used to perform a wide variety of safety inspection work for bridges, culverts and other structures. Inspection related work may include, but is not limited to:

- Routine and In-Depth Inspections
- Special Inspections
- Underwater Inspections
- Bridge capacity analysis and ratings
- Special Studies and testing
- Other related work

Districts are to utilize engineering agreements for inspection work to augment staff resources and expertise to ensure NBIS/NTIS compliance and maintain public safety.

Where structure systems at a single location are designated by multiple Bridge Management System (BMS2) numbers, ensure consistent inspection procedures, documentation, reporting, and overall quality control throughout the inspection process. When using an engineering agreement, a single prime engineering consultant shall be used to inspect the structure system to obtain these objectives.

1.10.2 District Inspection Agreements

It is preferred that the Districts maintain their own inspection agreements to provide for their ongoing and anticipated needs. For emergencies, unanticipated needs, or when special expertise is required, utilize BIS inspection agreements.

For underwater inspections by divers of Department or local bridges, it is preferred to utilize BIS's statewide agreements established for that purpose, rather than separate District agreements. At this time, only Engineering District 3-0 is maintaining dive teams capable of performing NBIS underwater inspections.

Some Districts have maintained District-wide or Countywide engineering agreements for local bridge inspection, where the local bridge owners have needed the Department's assistance routinely to maintain NBIS/NTIS compliance. This approach can be advantageous where greater District control is desired or when there are a large number of bridges or owners involved.

Funding for NBIS Length Local Bridge inspection work under ECMS agreements is provided through the BOMO fiscal year budget. Accordingly, all ECMS District owned agreements for Local bridge inspection work requires funding approval from BIS for all parts, work orders and amendments of those agreements prior to being created under the ECMS agreement. Funding approval will require the District to submit to BIS a detailed cost estimate for all parts, work orders and amendments as well as a bridge list or list of tasks associated with all parts, work orders and amendments. Once the part, work order or amendment is in legal processing the District is required to submit to BIS a Project Expenditure Approval Form (Pink Sheet) for processing by BOMO fiscal (contact BIS for a blank form).

1.10.3 BIS Inspection Agreements

BIS maintains several engineering agreements to be used by the Districts and local bridge owners for inspection-related work to:

- Ensure NBIS/NTIS compliance for all PA bridges
- Ensure adequate resources are available for immediate response to emergencies
- Provide specialized expertise

1.10.3.1 UNDERWATER INSPECTION AGREEMENTS

BIS routinely has multiple statewide underwater inspection agreements available for use on Department and Local bridges. The use of these contracts is preferred, rather than separate agreements.

Early in January of each calendar year, BIS will request the Districts to prepare a list of Department and local bridges that need to have underwater inspections performed under the auspices of the BIS agreements. BIS will assign the bridges to the appropriate agreement based upon special inspection needs, consultant workload, geographic economy and other factors. This early request for the list of needed underwater inspections assists in project planning and economy.

If an emergency arises, contact BIS for immediate assistance.

1.10.3.2 ACCESS TO BIS AGREEMENTS FOR LOCAL BRIDGES

Local bridge owners cannot directly access the BIS agreements. The Districts are to coordinate inspection needs for local bridges and include them in Work Order requests to BIS.

1.10.3.3 PROCEDURES TO UTILIZE BIS INSPECTION AGREEMENTS

In addition to the instructions in the Department's Policy and Procedures for the Administration of Consultant Agreements, Publication 93, the following procedures were established to make these agreements available to all Districts and to assist in their management:

1) Request for Work Order – Districts are to contact BIS's bridge inspection agreement manager to request authorization to utilize a BIS Agreement. A telephone call will suffice. BIS will assign a Work Order # for the appropriate agreement.

   More than one Work Order may be required if bridges involved are of more than one inspection funding category.

2) Scope of Work – Districts are responsible to determine the scope of work required at each bridge for the Work Order. BIS will provide assistance for unusual or special situations. The District may work with the consultant in developing the scope. Each agreement is based on the Scope of Work standard at

the time of development, so only special requirements usually need to be identified.

3) Work Order Costs – Districts are responsible for funding the cost of the Work Order.

For COST PER UNIT OF WORK agreements, only the list of bridges and units of work on each are required for scope and cost. The Work Order cost will be based on contract unit prices.

4) Work Order Preparation – District prepares and executes Work Order. Routing as per Publication 93 will result in circulation to BIS for approval.

5) Control of Work – District is responsible for quality control review of work products produced. District reviews inspection reports to ensure acceptability. District updates BMS2 as needed. Note, for local bridge inspections, additional data is needed on BMS2's 1A, 4A, 6A, 6B and 7A screens to recoup local share from Liquid Fuels tax allocation.

6) Invoices – District forwards signed invoices to BIS for processing and payment.

7) Close out – District closes out work order or part immediately after final invoice and acceptance in BMS2. This is critical to uncommit funding for future Work Order creation and increasing capacity of contracts.

1.10.4 Preparation of Safety Inspection Agreements

This section supplements Department's Publication 93 to provide guidelines for the preparation of safety inspection agreements to ensure statewide compliance with Department policies.

1.10.4.1 STANDARD SCOPES OF WORK FOR SAFETY INSPECTION AGREEMENTS

Standard scopes of work have been established for various types of safety inspection agreements and are contained in the following appendices:

- Appendix IP 01–F General Scope of Work - Safety Inspection of State and Local Bridges
- Appendix IP 01-G General Scope of Work – Safety Inspection of State and Local Tunnels
- Appendix IP 01–H General Scope of Work - Underwater Inspection of Bridges

Utilize these standard scopes of work as the basis for safety inspection engineering agreements whenever possible. Electronic versions of these standard scopes of work are available from the BIS.

The Scope of Work (SOW) for all the inspection types indicated above, except for tunnels, requires draft inspection reports to be submitted to the Department within 30 days from the date of the field inspection. The SOW for tunnels indicates the draft inspection report is to be submitted to the Department within 60 days of the completion of the field inspection. Particular emphasis needs to be placed on the draft inspection report to facilitate review and comment prior to acceptance of the final inspection report. This also ensures that BMS2 is updated within timeframes specified by NBIS/NTIS. The timeframe to update BMS2 for state bridges is 90 days, and the timeframe to update BMS2 for local bridges is 180 days from the date of the field inspection. The timeframe to update BMS2 for all tunnels is 3 months after the completion of field inspection.

1.10.4.2 GUIDELINES FOR PREPARATION OF SAFETY INSPECTION AGREEMENTS

To assist the Districts, Guidelines for Preparation of Safety Inspection Agreements are contained in Appendix IP 01-J.

1.11 FUNDING CATEGORIES FOR SAFETY INSPECTION

Funding categories have been established for some ongoing safety inspection work, based upon Federal Aid agreements with FHWA and on Department fiscal management requirements. The Multi-Modal Project Management System Numbers (MPMS), Federal Project Numbers (FPN) and Work Breakdown Structures (WBS), as shown in Table IP 1.11-1 (below) are to be utilized for in-house staff and inspection agreements.

All Inspection Agreements shall use General Ledger (**GL**) Account #**6341100**.

The need to include Fiscal Year (FY) in coding of the WBS element number has been eliminated, and this practice should no longer be used. WBS elements can only be used on one (1) MPMS number and therefore should be used on multiple agreements to accommodate WBS creating in the future.

Table IP 1.11-1 Multi-Modal Project Management System Numbers (MPMS), Federal Project Numbers (FPN) and Work Breakdown Structures (WBS) for Inspection Work

Description	MPMS	FPN	WBS
State DOT Owned Structure Inspection (Non-NBIS Length)	114961	N/A	0IN**dd**N09**###**-**unit**-611
State DOT Owned Structure Inspection (NBIS Length)	114961	N/A	0IN**dd**N09**###**-**unit**-311
Locally Owned Structure Inspections (NBIS Length)	104410	NBIS-070-M240	0IN**dd**N09**###**-**unit**-315
State DOT Owned Sign Structure Inspection	94921	SIGN-060-M240	0IN**dd**S09**###**-**unit**-383
State DOT Owned Retaining Wall Inspection	94921	WALL-060-M240	0IN**dd**W09**###**-**unit**-383
State DOT Owned High Mast Light Inspection	94921	WALL-060-M240	0IN**dd**H09**###**-**unit**-383

LEGEND for WBS Element Coding Key:

dd = District/Agency where work is performed (2 digits):
dd = District Number; 20 = DCNR; 21 = Other State Agency (OSA); 49 = State Wide

= Corresponds to Work Order, Part or Department staff (3 digits):
= Work Order # or Part Number # (ex: 001) or "111" for Department Staff

unit = Funding Code for District completing the inspection (4 digits) for Routine Inspections or for Central Office (4954) managed specialized inspections (i.e. Underwater, Fracture Critical, etc.)

Note: For Federal definition of NBIS, See Publication 100A, Item 5E01, NBIS Bridge Length.

1.12 STATEWIDE BRIDGE INSPECTION CRANE PROGRAM

1.12.1 Purpose of Bridge Inspection Crane Program

The Department maintains a statewide fleet of under-bridge inspection cranes to assist with the inspection and maintenance of PA bridges. The main purposes of this inspection crane program are:

- Better bridge inspection information – by providing inspectors easy access to remote portions of bridges that are difficult to access by climbing, more hands-on inspection is possible, providing more complete and accurate data.
- Improved emergency response – the cranes provide instant access to remote portions of the bridge allowing the inspectors and engineers better and timelier data. The cranes also provide access for persons who could not climb the structure.
- Improved safety for inspectors – the cranes provide a secure platform allowing inspectors to workhands free and avoid difficult climbing
- Cost savings – by reducing the time needed for inspectors to reach portions of the bridge and also avoid the erection of costly temporary scaffolding or platforms, significant time and costs savings are realized.
- Improved bridge maintenance – improved access is also available for in-house bridge maintenance

activities, affording the opportunity to provide timely maintenance or repairs and avoid costly scaffolding or rigging.

The statewide bridge inspection crane program is organized to share crane equipment on a regional basis to ensure that bridge inspection and maintenance needs throughout the state are met efficiently and in a timely manner.

1.12.2 Statewide Organization and Operations

The Department under-bridge inspection crane fleet consists of 6 truck-mounted cranes organized in a statewide program to share crane equipment on a regional basis.

1.12.2.1 CRANE DEPLOYMENT

The Department's under-bridge crane fleet consists of six truck-mounted cranes with rotating and articulated arms to carry inspectors from the deck to the underside of the bridges. The six cranes are deployed on a regional basis to better serve the statewide bridge needs and the individual Districts' inspection efforts. The state is roughly split into East and West along Engineering District boundaries and each half has three cranes. The individual cranes are assigned to a Home District and each Home District (except District 11-0) has a sharing District to which it is primarily responsible for crane services. The deployment of the statewide fleet is shown in Table IP 1.12.2.1-1.

Table IP 1.12.2.1-1 Deployment of the Department's Statewide Bridge Inspection Crane Fleet

Region	Primary Districts	Home District	Crane #	Crane Details
EAST	4-0 & 5-0	5-0	# 9	Aspen Aerial 50' reach 3 person bucket GVW = 66,350 lbs.
	2-0 & 3-0	3-0	# 5	Aspen Aerial 60' reach 3 person bucket Contact District for GVW
	6-0 &8-0	8-0	# 6	Aspen Aerial 60' reach 3 person bucket GVW = 67,400 lbs.
WEST	1-0 & 10-0	10-0	# 10	Aspen Aerial 55' reach 3 person bucket GVW = 64,000 lbs.
	11-0	11-0	# 13	Aspen Aerial 60' reach 3 person bucket GVW = 66,900 lbs.
	9-0 & 12-0	12-0	# 14	Aspen Aerial 30' reach 3 person bucket GVW = 36,500 lbs.

1.12.2.2 MANAGEMENT AND STAFFING FOR CRANES

- MANAGEMENT: Home Districts are responsible for overseeing the day-to-day operations of the crane assigned to that region, including full-time crane operators, maintenance, transport, inspection equipment, etc. This management role is generally assigned to the Assistant District Bridge Engineer for Inspection.
- STATEWIDE COORDINATION: The BIS is responsible for the coordination of the overall statewide crane inspection efforts among all the Districts.
- PERMANENT CRANE OPERATORS: Each Home District shall provide two permanent crane operators from the Bridge Inspection Crane Technician series from PA Civil Service to staff the Home District crane.
  - Lead Operator – Classification: Bridge Inspection Crane Technician Supervisor (BICTS)
  - Assistant Operator – Classification: Bridge Inspection Crane Technician (BICT)

  The permanent crane operators have the primary responsibility for the transport and operation of the crane, traffic setups, and bridge inspection duties.
- BACKUP CRANE OPERATORS:

  - o Each Home District is responsible to have a backup crane operator certified at the equipment operator BI level and available to the inspection program.
  - o Each Home District is responsible to have 2 persons from inspection and/or maintenance staff trained and certified to operate the bucket of the crane at the BB level.
- ▪ BRIDGE INSPECTORS: Each District is responsible to provide certified bridge safety inspector(s) to take the technical lead and responsibility for the inspection. The BICT and BICTS may assist in the inspection.

1.12.2.3 SAFETY AND MAINTENANCE OF TRAFFIC

The overall crew and public safety at the bridge site, including crane operations and traffic considerations, shall be the responsibility of the Lead Crane Operator. The Lead Operator shall have the authority to direct the maintenance and protection of traffic (MPT) set up and the inspection operations at the bridge site to ensure its safety.

Generally, each crane and its support vehicle have sufficient MPT equipment for most operational setups. When additional equipment or staffing is needed, the District in which the inspection is being performed is responsible to obtain and schedule it to coincide with the crane operations.

Each District is responsible to see that its bridge site is properly prepared for the bridge crane. For example, tree branches that may interfere with the crane deployment should be removed and electrical lines de-powered prior to the crane inspection for safer and more efficient operation.

1.12.2.4 CRANE SCHEDULING

The season of operation for the cranes is from mid-March to mid-December of each year. This annual schedule avoids severe winter weather that can affect the safety and efficiency of the operation. This scheduled downtime also allows for the necessary annual crane major maintenance inspection and service. The Department tries to maintain one operational crane at all times for emergencies.

A solicitation of statewide bridge crane needs for inspection and maintenance is made in December of each year via Strike-Off Letter in order to prepare the next season's schedule. The Districts are to incorporate local bridge inspection needs into their request when it is feasible and reasonable.

An important aspect of the scheduling is the sharing of the cranes with Districts outside their primary region. The cranes have varying capabilities and each District will have special inspection needs so the cranes must be shared to address PA's critical inspection needs. The cranes were purchased and deployed on a statewide basis and should not be considered as District cranes. Districts should also plan key bridge maintenance activities where the use of the cranes is advantageous.

In February, inspection staff and crane operators meet to review the various District requests and set a schedule to best accommodate them. The work is prioritized and matched up with the individual crane capabilities. BIS issues a Strike-Off Letter announcing the upcoming season's statewide schedule by the end of February each year.

If a bridge emergency arises after the annual crane schedule is issued, contact the District Bridge Engineer in the Home District for your region. If the Home District crane is not available or not suited for the emergency, the Home District will assist in obtaining a crane. BIS can also assist in emergencies.

1.12.2.5 CRANE USAGE REPORTING

Each Home District is to submit a monthly crane usage report to BIS who will then compile a statewide crane usage report.

1.12.3 Crane Maintenance and Repairs

Each Home District will be responsible for routine maintenance on the bridge inspection cranes, including

#2 PMs. Each Home District will be also responsible for the maintenance and replacement of the support van and equipment.

Major crane repairs (costing more than $5,000), annual crane inspections, major rebuilds, and replacements will be part of the statewide equipment budget.

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2.1 GENERAL REQUIREMENTS

The requirements of this manual apply to all bridges and structures located on or over public roads in PA, as defined in IP 1.5.

2.1.1 Department Organization for Bridge Safety Inspection

DEPARTMENT OF TRANSPORTATION: §650.313 of the NBIS (§650.513 of the NTIS) requires that each state provide an inspection organization capable of performing inspections, preparing reports, and determining ratings in accordance with NBIS/NTIS. In PA, the Department of Transportation was named and empowered to perform these duties as necessary for all public road bridges greater than 20' in length through Act 44 of 1988.

BRIDGE INSPECTION SECTION: The Department assigned the responsibilities for overseeing and managing these inspections to the Bridge Inspection Section (BIS) within the Bureau of Maintenance and Operations (BOMO). BIS also has the responsibility to collect, maintain and report the required data to the Department and ultimately, the FHWA. To perform these duties, BIS is to maintain an adequate and qualified staff and an effective Bridge Management System (BMS2).

DISTRICT BRIDGE UNIT: In each of the Department's Engineering districts, the District Bridge Unit is responsible for inspecting and/or directing the inspection of the bridges and structures in its area. The following guidance for staffing key functional positions in the Bridge Unit is provided:

- District Bridge Engineer: Must be knowledgeable of inspection policies and procedures. Responsible for reviewing bridges in critical condition and handling emergency situations involving all structures within their District.
- Assistant District Bridge Engineer for Inspection: Must be qualified to be the individual in charge of the NBIS inspection program, and the NTIS inspection program if tunnels are present within their District. Supervises or manages the day-to-day operations of the District inspection efforts. For Home Districts, this person is designated as the supervisor/manager for the crane operation.
- Bridge Inspection Teams: Each District Bridge Unit shall have qualified, certified, and adequately equipped inspection teams comprised of either full time PennDOT employees or consultants.
- Load Rating Engineer: Each District shall have qualified engineer(s) to perform or review bridge analyses and ratings for inspections. Load ratings shall be performed by or under the direct supervision of a registered Professional Engineer.
- APRAS Review Engineer: Each District shall have qualified engineer(s) to use APRAS and perform needed reviews for heavy hauling permit reviews.
- BMS2/*i*Forms Coordinator: Each District shall designate a staff member to ensure that inspection data is entered into *i*Forms database and the BMS2 in a timely and correct manner.
- Bridge Inspection Crane Operators:
  - Each Home District shall have two permanent crane operators in the BICT series assigned to the crane inspection program (see IP 1.12).
  - Each Home District shall have one back-up operator certified as a Crane Operator at the BI-level.
  - Each Home District shall have two back-up operators (from inspection staff or maintenance) certified as Bucket Operators [equipment certification level BB] to assist with the crane (see IP 1.12).
- Local Bridge Inspection Coordinator: Each District shall designate a staff person to coordinate bridge inspections with local bridge owners to ensure PA's compliance with NBIS/NTIS.

Depending upon District organization, resources, and workload, some of the above positions may not warrant a full-time staff person in an individual District, while others may require more than the minimum listed. For example, a District experiencing a large number of heavy overload permits applications may need more staffing in the bridge rating and/or APRAS review areas. However, for each functional area above, the Districts are to designate a lead person. Additional resources may be added through in-house staff or consultants.

By January 31 of each year, the Districts are to submit a staffing report for their inspection efforts in their District to the Bridge Inspection Section Chief. The report should include an organization chart and staffing list. The staffing list is to include any required certification (such as PE licensure, inspection certification (including training and experience), CDL, etc.).

2.1.2 Inspection Organizations in Other PA State Agencies

Other PA State agencies that maintain an independent inspection organization, such as the Turnpike and DCNR, are to demonstrate to the Department, on an annual basis, that their organization meets the NBIS/NTIS requirements for an inspection organization as applicable.

2.1.3 Qualifications for Program Manager and Safety Inspectors

2.1.3.1 PROGRAM MANAGER

The Program Manager (PM) must meet the minimum qualifications as described in the NBIS §650.309 and NTIS §650.509. The Bridge Inspection Section Chief will serve as the overall PM for bridge and tunnel inspections. The PM is responsible for completing and passing PennDOT's bridge inspection training class and refresher classes every two (2) years and an FHWA-approved tunnel inspection training class and refresher training every five (5) years. The PM must maintain supporting documentation of completed trainings. In addition, the PM needs to be able to determine when inspection team leaders must meet additional requirements for complex tunnels.

2.1.3.2 BRIDGE/CULVERT SAFETY INSPECTORS

Bridge inspection team leaders are to meet the minimum qualifications as described in the NBIS §650.309.

For State and Locally owned bridges, all inspection personnel must hold a valid certification as Bridge Safety Inspector issued by the Department. The only exception exists for underwater divers and those specific qualifications are outlined in Appendix IP 01-H. Team members shall become certified within 12 months of their hire date. If certification is not achieved within that time period, the individual will not be allowed to serve as a team member until certification is achieved.

BIS maintains a listing of inspection personnel who have recently attended our Department's bridge safety inspection courses and their current certification status. The Department's Bridge Inspection Section Chief will make the final determination of an individual inspector's qualifications.

2.1.3.3 TUNNEL SAFETY INSPECTORS

Tunnel inspection team leaders shall meet the minimum qualifications as described in NTIS §650.509. General tunnel inspectors shall have the training and expertise to inspect tunnels. It is recommended that all tunnel inspectors be Nationally Certified Tunnel Inspectors (NCTIs), however, it is not a requirement. The TOMIE Manual, Chapter 4 outlines additional recommended team members for tunnel inspections and their minimum qualifications including discipline specific specialists and specialty contractors. All tunnel safety inspectors are responsible for maintaining supporting documentation of completed trainings and qualifications. A registry of qualified team leaders and NCTIs is maintained by the Department's PM (see IP 2.1.3.1).

2.2 INSPECTION PROCEDURES

2.2.1 Bridge and Structure Inventory and Inspection Records

Records containing the inventory and condition information for bridges and structures are a vital key to managing these critical assets and assuring public safety. Accordingly, inventory and inspection records are to be prepared and maintained in accordance with IP 5 and IP 8.

2.2.2 Load Rating and Posting

Each bridge or structure carrying vehicular traffic requiring inspection under this Manual shall be rated to determine its safe load carrying capacity in accordance with IP 3. For tunnel ratings also reference the TOMIE Manual, Section 5.4.

Re–rating of a bridge is required when changes in its member conditions or its loadings occur. This re-rating must be completed and entered into BMS2 as soon as practical, but within 60 days of the inspection where such changes were noted or other notification of such changes.

Bridges that have been closed for rehabilitation must be re-rated and have load rating data entered into BMS2 before the bridge is re-opened to the public. For phased re-construction, each portion of the bridge is to be load-rated before going back into service.

All new bridges must be load rated and must have load rating data entered into BMS2 before the bridge is opened to the public. The review of bridge load capacity ratings, done in conjunction with safety inspections, is to be documented in BMS2.

If it is determined that the maximum legal load configurations exceed the load allowed at the Operating Rating level (see IP 3.2.2), then the structure must be posted for load restriction in accordance with IP 4 of this Manual and the Manual for Bridge Evaluation (MBE).

2.2.3 Identification of Bridge Needs

One of the functions of the bridge (and structure) inspection program is to identify the needs of bridges for repairs, maintenance, preservation, reconstruction and replacement. Bridge owners need this information to respond to those critical findings warranting immediate attention as defined in NBIS §650.305 and discussed in NBIS §650.313 and NTIS §650.513 and for the long-term management of these critical infrastructure assets. Critical findings and associated actions are discussed in further detail in IP 2.13 and IP 2.14. The FHWA requires the major improvement needs for NBIS bridges for nation-wide planning. The BMS2 will use these major improvement needs and identified maintenance needs to predict future costs to achieve a desired level of service for PA bridges and structures.

Identify needed maintenance items (e.g., on-demand repairs, preventative maintenance, preservation) for each bridge using the standard list of Maintenance Activities on *i*Forms Form M. Major improvement needs (e.g., rehabilitation, replacement) can be recorded as per the instructions for the 3A and 3B Screens in the BMS2 Coding Manual, Publication 100A.

2.2.4 Use of *i*Forms® Software for Electronic Collection of Bridge Inspection Information

The Department developed an application to enable all inspectors to collect bridge inspection data electronically at the bridge site and to transfer that digital data to the BMS2 Oracle database. The two main advantages the Department gained from this software are:

- Higher quality data through on-line edit checks and elimination of redundant data entry to BMS2
- Time savings for field inspectors

The application is named *i*Forms and its purpose is to electronically collect bridge safety inspection information. *i*Forms collects all field inspection data for all inspection types. The screen layout is patterned after the D-450 series inspection forms. Both the BMS2 Items and the narrative comments supporting those ratings are stored in the BMS2 database. *i*Forms also prints an inspection report.

The Department's *i*Forms software is to be used for all highway bridge inspections.

2.2.5 Identification of Bridge Utility Occupancies

On Department bridges greater than 8' in length, all bridge occupancies are to be identified and recorded on the Features (FT) Screen of BMS2. This information allows the Districts to identify the responsible party when a problem or deficiency is noted on the utility itself or its supports. During Routine Inspections, bridge inspectors do not need to inspect the utility facility, but should note if mounting hardware, utility joints, utility occupancies, etc. present a hazard to the public or are detrimental to the bridge condition.

Bridge deck de-icing systems and traffic monitoring detection systems, while not strictly a utility occupancy, should also be recorded on the BMS2 FT screen.

2.2.6 Bridge and Structure Information for APRAS

The Districts are to maintain in BMS2 accurate and up-to-date load capacity and clearance information for APRAS for all bridges and structures that carry or cross over State Routes or that are owned by the Department.

For bridges that carry State Routes or are owned by the Department, the bridge load capacity data and clearance information are required in the APRAS screens in BMS2. For locally owned bridges on State-owned Roads (LOBSTORs), the Districts are responsible to gather and maintain the APRAS data (BMS2's SC, SL and SS Screens) and RMS location references (on BMS2's 5C and 6C screens) to enable the automated processing of Heavy Hauling Permits.

The Districts are reminded that the Department should not be issuing permits to travel over LOBSTORs without the consent of the owner. Blanket authority to allow the Department to issue permits over LOBSTORs when the Department follows its permit review procedures may be granted by the Owner.

For bridges that carry local roads (or Turnpike) over State Routes, the Districts are responsible to gather and maintain the APRAS data (except bridge load capacity information) and RMS location references (on BMS2's 5C and 6C screens) to enable the automated processing of Heavy Hauling Permits.

For non-highway bridges or structures over State Routes, the Districts are responsible to gather and maintain the APRAS clearance data and RMS location references (on BMS2's 5C and 6C screens), regardless of the structure ownership, to enable the automated processing of Heavy Hauling Permits.

2.3 GENERAL TYPES OF BRIDGE SAFETY INSPECTIONS

As described in Section 4.2.3 of the MBE, there are seven general types of bridge inspections: Initial, Routine, Damage, In-Depth, Special, Underwater and Fracture Critical Inspections. The TOMIE Manual describes five general types which are in line with the first five listed in the previous sentence. The scope, intensity, and interval of various types of general bridge safety inspections are discussed here to provide a better understanding of the purpose and use of each inspection type and to assist in the development of scope of inspection work for individual inspections.

An inspection event, particularly for large, complex, or deficient structures, often requires that a variety of inspection types be performed, using a variety of methodologies. For example, a fracture critical member will routinely receive a hands-on inspection, while the remainder of the bridge may not. In another example, the underwater inspection of a particular structure may require that specific elements receive in-depth inspections, while other underwater elements may require only routine inspection. The following sections of this chapter describe each of the first five general types of inspections listed above (Initial, Routine, Damage, In-Depth, and Other Special), along with the purpose, level of work effort or intensity, and interval. Note: The term Other Special is used rather than Special to provide consistency with BMS2 and AASHTOWare. Fracture Critical Inspections are outlined in IP 2.4 and Underwater Inspections in IP 2.6.2 of this Manual and do not apply to tunnels.

The Department has developed a standard General Scope of Work for the Safety Inspection of State and Local Bridges and General Scope of Work for the Safety Inspection of State and Local Tunnels to be used as the basis for inspection agreements. These Scope of Work (SOW) documents are intended to provide the framework to cover the types of inspections listed above and allow the user to define additional special requirements and/or efforts. Refer to IP 1.10 for instructions on developing bridge inspection agreements.

Owners of large, complex bridge structures such as movable, suspension, cable-stayed, and other bridges with unusual characteristics including all tunnels must have published inspection procedures and inspection team qualification requirements for the structure(s). The procedures should cover the inspection interval, scheduling and requirements for In-Depth inspections, traffic control, special equipment, methods of access, and locations or specific components on the structure where hands-on inspection is required for each inspection. The requirements for any special inspection techniques such as NDT shall be identified including the locations where applicable. In addition, indicate all discipline specific specialists and specialty contractors as required. The bridge owner is to maintain a copy of the complex bridge inspection plan/procedures with an electronic copy in BMS2 through the Documents link.

An effective plan must address inspection of each of the various systems or subsystems of the complex structure. For example, a movable bridge inspection must include the machinery, electrical, mechanical and hydraulic systems that are typically present, in addition to the structural load path components. The plan should address the inspection techniques, tests and measurements that should be applied. Health and safety considerations should also be evaluated. Coordinate with local and state police, fire departments, ambulatory and medical services in advance, particularly when dealing with confined space.

Within these general types of inspections, the term "inspection type" is used for two other purposes:

- Primary Inspection Type (BMS2 Item 7A03) for inspection management
  - Created by the Department
  - Used to better describe the type and function of the inspection
  - See Table IP 2.3.6.6-1 and Table IP 2.3.6.6-2 for correlation between Item 7A03 and Compliance Inspection Types for NBIS and NTIS respectively
- Compliance Inspection Type (BMS2 Items 7A06-7A10)
  - Required by NBIS/NTIS
  - BMS2 data used for scheduling and monitoring of compliance of inspections required by NBIS/NTIS
  - See IP 2.3.6 for additional information

Element-level inspections are not a separate type of inspection, but rather a term that refers to the collection of bridge condition information at the element level in addition to the component condition ratings required for the NBI. The NTI does not require component condition ratings for tunnels, only element-level data. Element-level data will be submitted annually to FHWA as part of the NBI/NTI for all NBIS length bridges and NTIS tunnels that have element-level data in BMS2. Element-level data collection is generally performed with NBI/NTI inspections (7A03 = R, C, F, or W) but may be done with other types. One of the primary purposes of element-level data is the development of deterioration and cost models to predict the future condition of bridges and the attendant budgeting needs.

Element-level inspection data will be collected for all NHS bridges, both state and locally owned. In addition, element-level inspection data will be collected for all state-owned bridges greater than 8 feet in length and all tunnels. Although the collection of element-level data is not required for locally-owned bridges that are not on the NHS system, it is recommended.

For local bridges and other non-Department bridges, the Department recommends that owners specify their consultant to collect element-level data for their bridges. BMS2 is available to all owners for element-level data collection. When element-level data is completed for an inspection, the inspector must verify that the inventory of elements is complete for the bridge and add any missing elements. Provide Condition State data for BMS2 Items 1A10 and 1A11 in accordance with Publication 100A. This data is to be entered into BMS2 with the other inspection information. Once element-level inspection has been performed and data added to BMS2, "check" the data box for ELEMENT inspection for BMS2 Item 7A06 (Inspection Performed).

For tunnel inspections, element-level data shall be collected and reported in BMS2 in accordance with the SNTI for all tunnels, regardless of ownership. Publication 100A, Appendix D provides correlations between SNTI coding and BMS2 coding.

2.3.1 Initial (First Time) Inspections

2.3.1.1 DESCRIPTION OF INITIAL (FIRST TIME) INSPECTIONS

An Initial (First Time) Inspection is the first inspection of a new or existing structure, as it becomes part of the structure inventory. Additionally, major reconstruction of structures may also require an Initial (First Time) Inspection to document more extensive modifications of the structure's type, size, or location. In general, widening, deck and superstructure replacements warrant an Initial (First Time) Inspection. The Initial (First Time) Inspection is to include an analytical determination of load carrying capacity. An Initial (First Time) Inspection is also an

NBI/NTI (Routine) inspection and is considered a Compliance Inspection for both NBIS and NTIS. This inspection type should not be used for the sole purpose of reviewing repairs to limited elements of the structure.

2.3.1.2 PURPOSE OF INITIAL (FIRST TIME) INSPECTIONS

The Initial (First Time) Inspection is to verify the safety of a bridge, in accordance with the NBIS/NTIS and Department standards, before it is put into service or within the timeframe detailed in IP 2.3.1.4. The inspection serves to provide required inventory information of the "as-built" structure type, size, and location for BMS2 (and the NBI/NTI) and to document its structural and functional conditions by:

- Providing all Structure Inventory & Appraisal (SI&A) data required by Federal regulations along with all other data required by Department standards and the local owner.
- Determining baseline structural conditions. Clearance envelopes (for features carried and those intersected) and bridge waterway openings are to be documented at this time.
- Identifying and listing existing problems.
- Determining the need for establishing or revising a weight restriction on the bridge.
- Identifying and listing concerns of future conditions.
- Identifying maintenance needs, including preventative maintenance activities.
- Noting the existence of elements or members requiring special attention, such as fracture critical members, fatigue-prone details, and underwater members.

Documents including, but not limited to, photographs, drawings (design, as-built and shop drawings), scour analysis, foundation information, hydrologic and hydraulic data are to be inserted into the bridge file and uploaded to BMS2 Documents link. Selected construction records (e.g., pile driving records, field changes, photos) may also be of great use in the future and should be included. Include maintenance records for existing bridges.

2.3.1.3 INTENSITY OF INITIAL (FIRST TIME) INSPECTIONS

The level of effort required to perform an Initial (First Time) Inspection will vary according to the structure's type, size, design complexity, and location. An Initial (First Time) Inspection is to be a close-up, hands-on inspection of all members of the structure to document the baseline conditions. Traffic control and special access equipment may be required.

For tunnels, Initial (First Time) Inspections are to include all structural, civil, mechanical, electrical and lighting, fire and life safety, security, signs and protective systems.

2.3.1.4 INTERVAL OF INITIAL (FIRST TIME) INSPECTIONS

Best practice is for Initial (First Time) Inspections to be performed for each structure after construction is essentially complete and before the bridge is put into service (or returned to service for bridges that have had a major reconstruction). However, at a minimum:

- For Initial Inspections, Department bridges are to be inspected and accepted into BMS2 within forty-five (45) days of the date the bridge is put into service to ensure proper data for all required items in BMS2 and APRAS.
- For local bridges, up to one-hundred eighty (180) days for acceptance and data entry is allowed by NBIS. A shorter time frame is recommended, if possible.
- For tunnels, the Initial (First Time) Inspection shall take place after all construction is completed, after all functional systems are tested, but prior to opening the tunnel to traffic.

2.3.1.5 ELEMENT-LEVEL DATA COLLECTION FOR INITIAL (FIRST TIME) INSPECTIONS

The Initial (First Time) Inspection of bridges is to include a complete inventory of all elements and their condition states for BMS2 Item 1A10 and 1A11. This data is to be entered into BMS2 with the other Initial (First Time) Inspection information as per IP 2.3.1.4. It is recommended that the element inventory be completed before going into the field for the inspection. The inspector shall utilize design plans and calculations to help quantify element data. Once an element-level inspection has been performed and data has been added to BMS2, the ELEMENT data box for BMS2 Item 7A06 (Inspection Performed) is to be "checked" before the inspection record is saved. See IP 2.3 for additional information on element level data collection.

2.3.2 Routine Inspections

2.3.2.1 DESCRIPTION OF ROUTINE INSPECTIONS

Routine Inspections are also known as "NBI" or "NTI" inspections because they update the condition and inventory information required for the NBI/NTI. Routine Inspections document the existing physical and functional conditions of the structure. The Routine inspection should pay particular attention to critical areas of the structure such as at or under deck joints and drains, at bearings, at splices, connections, etc. All changes to required inventory items that have occurred since the previous inspection are also to be documented. The written report will include appropriate photographs and recommendations for major improvements, maintenance needs (preservation, preventative maintenance or on-demand repairs), and follow-up inspections. Load capacity analyses are re-evaluated only if changes in structural conditions or pertinent site conditions have occurred since the previous analyses.

2.3.2.2 PURPOSE OF ROUTINE INSPECTIONS

A Routine Inspection is to satisfy the requirements of the NBI/NTI and BMS2 and be performed in accordance with the NBIS/NTIS and Department standards. Routine Inspections serve to document sufficient field observations, measurements and load ratings needed to:

- Determine the physical and functional condition of the structure.
- Identify changes from the previously recorded conditions.
- Determine the need for establishing or revising a weight restriction on the bridge.
- Determine improvement and maintenance needs.
- Ensure that the structure continues to satisfy present service and safety requirements.
- Identify trends and predict future life expectancy of components.

2.3.2.3 INTENSITY OF ROUTINE INSPECTIONS

The level of scrutiny and effort required to perform a Routine Inspection will vary according to the structure's type, size, design complexity, existing conditions, and location. For tunnels, Routine Inspections are intended to be comprehensive covering the structural, civil, mechanical, electrical and lighting, fire and life, safety, security, signs and protective systems.

Generally, every element in a bridge does not require a hands-on inspection during each Routine Inspection to provide an acceptable level of assurance of the bridge's ongoing safety. The difficulty is that the areas not needing close-up scrutiny can be determined only after the entire bridge has been inspected and non-critical areas identified. Accordingly, to provide a reasonable level of confidence in the safety of the bridge, knowledge of the structure and good engineering judgment are necessary when considering those portions that will not receive the close-up scrutiny with each inspection.

The following guidance is offered when determining the level of scrutiny needed for adequate inspection of individual bridges:

1. Areas/elements that may be more difficult to access but that warrant hands-on inspection in each Routine Inspection, include, but are not limited to:
   - Load carrying members in Poor condition.
   - All Fracture Critical Members
   - All redundancy retrofit systems (e.g., Catcher-beams) for fracture critical details (pin hangers, etc.).
   - Critical sections of controlling members on posted bridges.
   - Scour critical substructure units.
   - End regions of steel girders or beams under a deck joint.
   - Cantilever portions of concrete piers or bents in Fair or lesser condition.
   - Ends of Prestressed concrete beams at continuity diaphragms.
   - Precast concrete bridge barriers.
   - Fascia beams of non-composite adjacent box beam bridges with open joints in the barrier.
   - All elements and system components within any tunnel.
   - Other areas determined by the District Bridge Engineer to be potentially critical.

NOTE: The condition of the bridge element noted above is based on the Condition Rating code list on Page 3-4 of Publication 100A. While the Publication 100A language is referring to the major NBI components (deck, superstructure, substructure, and culvert), the condition descriptions can also be applied to portions or elements thereof.

2. No portion of a bridge should go without a hands-on inspection at least once in every six years (every 8 years for bridges utilizing extended interval). If hands-on scrutiny of an element is performed during a Routine Inspection, it should be so noted in the inspection report. An example of inspection notes might read: "P/S Beams in good condition with no cracks or spalling noted when a hands-on inspection was completed from a crane."

The application of these guidelines for intensity of inspection does not relieve the engineer-in-charge of the inspection from the responsibility to perform other hands-on inspection tasks and/or tests needed to ascertain the condition of the bridge and assure its safety.

Routine Inspections are generally conducted from the deck, ground and/or water levels, ladders and from permanent work platforms or walkways, if present. Inspection of underwater members of the substructure is generally limited to observations during periods of low flow and/or probing/sounding for evidence of local scour. Special equipment, such as under-bridge cranes, rigging, or staging may be a necessary or more practical means of accessing areas of the structure being inspected hands-on.

2.3.2.4 INTERVAL OF ROUTINE INSPECTIONS

INSPECTION DATE AND INSPECTION INTERVAL: For the purpose of monitoring NBIS/NTIS compliance, FHWA measures Routine Inspection interval by the month and year only, not the exact date of inspection. The exact date of inspection (BMS2 Item 7A01) is still to be recorded but will not be used to check NBIS/NTIS compliance.

Routine Inspections are inspections that are regularly scheduled and of sufficient scope and intensity to provide the updated condition and inventory information required for the NBI/NTI. The maximum intervals of Routine Inspections and Other Special (Interims) Inspections have been established for bridges in PA in Table IP 2.3.2.4-1.

NTI Routine Inspections shall be completed every two years unless authorized for an extended interval by the BIS. PennDOT must make a written request justifying the extended interval to FHWA for review and comment prior to implementation. Table IP 2.3.2.4-1 provides criteria which reduces the inspection interval. The target month for NTI inspections shall be based on the target date. NTIS allows the inspection to be performed two months before or two months after the target date month and still be considered on time. The target date for Routine NTI inspections should not be changed once established without coordination with BIS and FHWA.

BRIDGES THAT LOSE ELIGIBILITY FOR EXTENDED INTERVAL: For bridges that are scheduled for a 48-month Routine interval, which no longer qualify, the following procedure shall be followed:

- Last Routine inspection occurred within the last 24 months: Create a Damage inspection to initiate the change in inspection interval. Complete the next Routine inspection 24 months after the last Routine was completed. Bridge must remain on a 24-month interval for at least one more cycle.
- Last Routine inspection occurred more than 24 months ago: Create a Damage inspection to initiate the change in inspection interval.- Perform a Routine inspection within 30 days of the date of the Damage inspection to keep the bridge in compliance (Note, a Routine inspection may be completed in lieu of the Damage inspection to keep the bridge in compliance instead of completing a Damage inspection and follow-up Routine inspection). Bridge must remain on a 24-month interval for at least one more cycle.

REDUCED INTERVAL INSPECTIONS FOR BRIDGES: When the bridge conditions have deteriorated to the point where more frequent inspection, in addition to the 24-month NBI inspections, is needed to ensure public safety, an Other Special (Interim) Inspection is to be required and scheduled. Table IP 2.3.2.4-1 specifies the reduced inspection interval based on a structure's condition. See IP 2.3.5 for additional information on Other Special (Interim) Inspections.

<table>
<tr><th colspan="4">Table IP 2.3.2.4-1 Intervals of Routine and Other Special (Interim) Inspections for State Owned Bridges ≥ 8' and Non-State Owned Bridges > 20'</th></tr>
<tr><th colspan="2">7A09
Insp Freq
(months)</th><th rowspan="2">Bridge Description</th><th rowspan="2">Comments</th></tr>
<tr><th>NBI/
NTI</th><th>OS</th></tr>
<tr><td>48</td><td>Not required</td><td>Bridge must meet all the following criteria:
▪ State or PTC owned (5A21= 01 or 31)
▪ State or PTC maintained (5A20 = 01 or 31)
▪ Deck (1A01), Superstructure (1A04), Substructure (1A02), and Culvert (1A03) Condition Rating ≥ 6 or N depending on the structure type
▪ Channel (1A05) and Observed Scour Rating (IN03) ≥ 4 or N depending on the structure type
▪ SCBI (4A08) = 5, 7, 8, 9 or N
▪ Known Foundation Type (IN13) ≠ P or X when Service Type Under (5A18) contains a waterway (i.e., 5 thru 9)
▪ Min. Vert. Underclearance (4A17) ≥ 14.5' (Over Non-Principal Arterial, 5C22 ≠ 1, 2, 3, 11, 12 or 14)
▪ Min. Vert. Underclearance (4A17) ≥ 16.0' (Over Principal Arterial, 5C22= 1, 2, 3, 11, 12, or 14)
▪ Non-Fracture Critical Bridge (6A44 ≥ 5)
▪ Structure Type is not Adjacent Non-Composite Box Beams (6A26-6A29 ≠ 42107)
▪ Structure Type is not a Stone Masonry Arch (6A26-629 ≠ 69920, 69820, or 69929)
▪ Structure Type is not a movable lift structure (6A29 ≠ 26)
▪ Posting Status (VP02) = A (Open, no restrictions)
▪ Inventory Rating ≥ State Legal Load:
IR (HS20) ≥ 36 tons
IR (ML80) ≥ 36.6 tons
IR (TK527) ≥ 40 tons
▪ Bridge has received a First time and one Routine Inspection after year built or year reconstructed or two consecutive Routine Inspections (24 months between said inspections)
▪ Bridge does not have any active or deferred Priority 0 or 1 Maintenance Items</td><td>Bridges meeting the extended NBI inspection interval of 48 months will be identified in BMS2 on the Ratings and Schedule Screen (7A19 = Yes).

In addition, each District will approve the use of extended NBI inspection interval in BMS2 on the Ratings and Schedule Screen (7A20 = Yes).

This interval is not applicable for tunnels.</td></tr>
<tr><td rowspan="3">24</td><td rowspan="3">Not required</td><td>Highway bridges without restrictions or conditions described below.</td><td></td></tr>
<tr><td>Closed highway bridges</td><td>See IP 2.7 for inspection requirements</td></tr>
<tr><td>Non-highway bridges and structures over State Routes</td><td>See IP 2.10 for inspection requirements</td></tr>
</table>

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Note: OS indicates Other Special (Interim) Inspection
NBI/NTI indicates Routine Inspection

Table IP 2.3.2.4-1 Intervals of Routine and Other Special (Interim) Inspections for State Owned Bridges ≥ 8' and Non-State Owned Bridges > 20'

7A09 Insp Freq (months) NBI/ NTI	7A09 Insp Freq (months) OS	Bridge Description	Comments
24	12	Highway bridges with weight restrictions (e.g., posted weight limit and/or restricted to One Truck at a Time) (VP02 = P or R)	Other Special (Interim) Inspections of critical areas only of a bridge are to be used to meet the reduced interval between the biennial Routine Inspections. When a reduced inspection interval is warranted, the inspection report is to list the justification, scope, intensity and interval for the next Other Special (Interim) Inspection in the recommendation section. For Highway Tunnels Interim Inspections shall be determined by owner and District Bridge Engineer and outlined in the Inspection Procedure document located in BMS2.
		Highway bridges classified as non-fracture critical (6A44 = 5, 6 or 9) with a Condition Rating of 3 for superstructure (1A04), substructure (1A02), channel (1A05) or culvert (1A03)	
		Highway bridges classified as fracture critical (6A44 ≤ 4) with a Condition Rating of 4 for superstructure (1A04).	
		Highway bridges of metal arch culvert construction (6A26 = 1 or 7 AND 6A29 = 20, 30, 32, 33, or 35) with a Condition Rating of 4 for superstructure (1A04), culvert (1A03) or substructure (1A02)	
		Highway bridges with an open steel grid deck (6A38 = 06) with a Condition Rating of 4 for the deck (1A01) or superstructure (1A04)	
		Highway bridges of masonry arch construction with a Condition Rating of ≤ 4 for superstructure (1A04), culvert (1A03) or substructure (1A02). See IP 2.5.3 and IP 2.5.4 for more instructions.	
24	6	Highway bridges classified as fracture critical (6A44 ≤ 4) with a Condition Rating of 3 for superstructure (1A04)	
		Highway bridges of metal arch culvert construction (6A26 = 1 or 7 AND 6A29 = 20, 30, 32, 33, or 35) with a Condition Rating of 3 for superstructure (1A04), culvert (1A03) or substructure (1A02)	
		Highway bridges with an open steel grid deck (6A38 = 06) with a Condition Rating of 3 for the deck (1A01) or superstructure (1A04)	
		Highway bridges with Condition Rating of 2 for superstructure (1A04), substructure (1A02), deck (1A01), channel (1A05), culvert (1A03) or SCBI (4A08)	
		Highway bridges with an Observed Scour Rating (IN03) of a 3 or less	
		Highway bridges with an SCBI of 6 (4A08)	
		Any temporary structure or bridge, or those with temporary supports, falsework or cribbing (VP02 = D or E)	

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Note: OS indicates Other Special (Interim) Inspection
NBI/NTI indicates Routine Inspection

LATE INSPECTION: A Routine NBI inspection exceeding 24/48 months will result in a reduced period until the next Routine NBI inspection. To prevent schedule creep following a late inspection, the required date of the next Routine inspection will be entered as 24/48 months from the previously scheduled date, and not from the actual date of the late inspection. This will result in a period of less than 24/48 months between a late inspection and the next required Routine inspection. For example, a Routine NBI inspection scheduled in August and conducted in October would be due again 24/48 months from August.

A Routine NTI inspection may be performed within two months before or two months after the target inspection month. If the inspection occurs within this time frame, the next inspection month is based on the target inspection month from this cycle. If an NTI inspection occurs more than two months past the target inspection month, this will result in a reduced period until the next NTI inspection. The next required NTI inspection date will still be based on the target date.

EARLY INSPECTION: An NBI inspection conducted before its scheduled date, i.e., less than 24/48 months, will result in a change to the date for all future NBI inspections. For example, to adjust work load in a given period, the inspection of a given bridge may be conducted before its 24/48-month interval. The required date of the next NBI inspection following an early NBI inspection will then be based on the 24/48-month interval established from the date of the early NBI inspection to ensure the time lapse between inspections does not exceed the NBI interval.

It is not recommended that an NTI inspection is conducted more than two months before its scheduled target date. If there is a valid reason to conduct the inspection sooner than two months before the target date, the Owner shall contact the Bridge Inspection Section Chief and FHWA for written approval.

EXTENDED NBI INSPECTION INTERVALS (LONGER THAN 24 MONTHS) FOR NBIS BRIDGES: When an NBI (routine) inspection interval longer than 24 months is proposed for an NBIS highway bridge (greater than 20 feet), the bridge must meet the criteria in Table IP 2.3.2.4-1.

2.3.2.5 ELEMENT-LEVEL DATA COLLECTION FOR ROUTINE INSPECTIONS

Element-level data is required to be collected during the Routine Inspection of all Department bridges, locally owned bridges located on the NHS, and all tunnels. The collection of this data is optional for locally owned bridges not on the NHS. When element-level data is completed for a Routine Inspection, the inspector must verify that the inventory of elements is complete for the bridge and add any missing elements. Provide Condition State data for BMS2 Items 1A10 and 1A11. This data is to be entered into BMS2 with the other inspection information. Once element-level inspection has been performed and data added to BMS2, “check” the data box for ELEMENT inspection for BMS2 Item 7A06 (Inspection Performed). See IP 2.3 for additional information on element level data collection.

2.3.3 Damage Inspections

2.3.3.1 DESCRIPTION OF DAMAGE INSPECTIONS

Damage Inspections are performed following extreme weather-related events, earthquakes, fires, explosions, vandalism and vehicular/marine traffic crashes, as directed by the District Bridge Engineer. In many ways, a Damage Inspection is a Special Inspection that is necessitated by an extreme event. When major damage has occurred, the inspectors will need to evaluate fractured or failed members, determine the amount of section loss, make measurements for misalignment of members, and check for any loss of foundation support. For Damage Inspections 7A03 = B.

When severe damage occurs, the bridge shall remain closed until a damage inspection has been completed.

2.3.3.2 PURPOSE OF DAMAGE INSPECTIONS

Damage Inspections serve to first determine the nature, severity, and extent of structural damage following extreme weather-related events, seismic events and vehicular or marine traffic collisions/accidents for use in designing needed repairs. A post-flood inspection is to be coded as a Damage Inspection. A Damage Inspection is to determine the immediate need to place an emergency restriction on a bridge (e.g., weight restriction or closure) for vehicular traffic. If a bridge is closed to vehicular traffic, the need to close it to pedestrian traffic should also be determined. A Damage Inspection does not satisfy the reduced interval for inspections.

The findings of a Damage Inspection may be used to re-coup the costs of inspection and needed repairs or reconstruction from involved parties or other governmental agencies. Accordingly, documentation of the inspection may be critical in these efforts. For Department bridges, the extent of damage and estimated costs of repair should be reported to the District Bridge Maintenance coordinator. Photographs, videos and sketches can be extremely helpful. This documentation should be released in accordance with IP 1.8. See IP 2.9 for additional information regarding reporting bridge and structure emergencies.

2.3.3.3 INTENSITY OF DAMAGE INSPECTIONS

The amount of effort expended on this type of inspection will vary significantly depending upon the extent of the damage, the volume of traffic encountered, the location of the damage on the structure, and documentation needs. The scope of a Damage Inspection will be sufficient to determine the need for emergency load restrictions or closure of the bridge to traffic, and to estimate the level of effort necessary to accomplish repairs. The capability to make an on-site determination of the need to establish emergency load restrictions may be necessary.

Structural materials may need further evaluation as identified in the MBE. For additional information on Damage Inspections for tunnels, see TOMIE Section 4.6.3.

2.3.3.4 INTERVAL OF DAMAGE INSPECTIONS

A Damage Inspection is an unscheduled inspection to assess the structural damage resulting from environmental factors or human actions. Damage Inspections are performed on an as-needed basis.

2.3.3.5 ELEMENT-LEVEL DATA COLLECTION FOR DAMAGE INSPECTIONS

Element-level data is always collected as part of tunnel inspections including Damage Inspections. For the inspection of bridges and culverts, it is generally not required for Damage Inspections; however, for floods and collisions where damage is known to have occurred and where it might be significant, element-level condition data could enhance planning for the future. Collection of element-level data should be made on a case-by-case basis for Damage Inspections.

If the owner elects to collect element-level data, provide Condition State data for all elements in BMS2 Items 1A10 and 1A11. This data is to be entered into BMS2 with the other inspection information. Once element-level inspection has been performed and data added to BMS2, “check” the data box for ELEMENT inspection for BMS2 Item 7A06 (Inspection Performed). See IP 2.3 for additional information on element level data collection.

2.3.4 In-Depth Inspections

2.3.4.1 DESCRIPTION OF IN-DEPTH INSPECTIONS

An In-Depth Inspection is a close-up inspection of one or more elements or functional systems 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. In-Depth Inspections are typically limited to certain elements, span group(s), or structural units of a structure, and need not involve the entire structure. In-Depth Inspections can be conducted alone or as part of a Routine or other type of inspection.

2.3.4.2 PURPOSE OF IN-DEPTH INSPECTIONS

In-Depth Inspections serve to collect and document data to a sufficient detail needed to ascertain the physical condition of a bridge. This “hard-to-obtain” data is more difficult to collect than data collected during a Routine Inspection. An In-Depth Inspection is not to be used to satisfy the reduced interval for Routine Inspections.

2.3.4.3 INTENSITY OF IN-DEPTH INSPECTIONS

The level of effort required to perform an In-Depth Inspection will vary according to the structure's type, size, design complexity, existing conditions, functional systems, and location. Traffic control and special equipment, such as under-bridge cranes, rigging, or staging may be needed for In-Depth Inspections. Personnel with special skills such as divers, riggers and certified technicians may be required. Non-destructive field tests and/or material tests may be performed to fully ascertain the existence of or the extent of any deficiency.

An In-Depth Inspection with a scope and intensity that satisfies the requirements of a Compliance Inspection must be coded as follows:

- For an NBI or FC Inspection: 7A03 = R, C, or W
- For an NTI Inspection: 7A03 = R,
- For an Other Special (Interim) Inspection: 7A03 = I

For large or complex structures, these inspections may be scheduled separately for defined segments of the bridge or for designated groups of elements, connections, details or functional systems that can be efficiently addressed by the same or similar inspection techniques. If the latter option is chosen, each defined bridge segment and/or each designated group of elements, connections, details or functional systems should be clearly identified as a matter of record and shall be assigned an interval for inspection. Components that may receive an In-Depth inspection can include pins, suspension cables, steel box beams, segmental concrete box beams, etc. The activities, procedures, and findings of In-Depth Inspections will be completely and carefully documented to an even greater extent than is necessary for Initial and Routine Inspections. Stated differently, In-Depth Inspection reports will generally be detailed documents unique to each structure that exceed the documentation of standard or routine inspection forms.

In-Depth Inspections of tunnels may involve testing of tunnel systems, components, and materials. Disassembly and cleaning of equipment and components may also be required.

A structural analysis for load carrying capacity may be required with an In-Depth inspection to fully evaluate the effect of the more detailed scrutiny of the structure condition.

2.3.4.4 INTERVAL OF IN-DEPTH INSPECTIONS

An In-Depth Inspection can be scheduled in addition to a Routine Inspection, though generally at a longer interval, or it may be a follow-up to a previous inspection.

In-Depth Inspections should be routinely scheduled for selected bridges based on their size, complexity and/or condition. Large bridges (longer than 500 feet) represent large capital investments and warrant closer scrutiny to ensure that maintenance work is identified and completed in a timely manner. Large bridges tend to be more critical to local and area transportation because of the usual lack of suitable detours. For large or complex bridges, it may be more difficult to provide a complete "snapshot" of the bridge conditions when access difficulties limit the scope of Routine Inspections.

The interval of In-Depth Inspections will be established by the bridge owner. In-Depth Inspections will be coded as such in BMS2 item 7A03 and can be part of, or independent from, a Routine Inspection.

In-Depth Inspections do not reduce the level of intensity for Routine Inspections as discussed in IP 2.3.2.3.

2.3.4.5 ELEMENT-LEVEL DATA COLLECTION FOR IN-DEPTH INSPECTIONS

Element-level data is generally not required for In-Depth Inspections. Since In-Depth Inspections are generally of limited scope (see IP 2.3.4.3), any change in element condition would not have a significant impact on a predictive bridge model (the primary purpose of this data) to warrant its collection. Collection of element-level data should be made on a case-by-case basis for In-Depth Inspections.

If the owner is required or elects to collect element level data, provide condition state data for all elements in BMS2 Items 1A10 and 1A11. This data is to be entered into BMS2 with the other inspection information. Once element-level inspection has been performed and data added to BMS2, "check" the data box for ELEMENT inspection for BMS2 Item 7A06 (Inspection Performed). See IP 2.3 for additional information on element level data collection.

2.3.5 Other Special (Interim) Inspections

During Other Special (Interim) Inspections attention should be given to posted bridges; poor, serious and critical condition ratings; or high priority maintenance recommendations. The results of the inspection of such items and need for follow-up should be properly noted on the reporting forms for each structure for which the items are applicable.

2.3.5.1 DESCRIPTION OF OTHER SPECIAL (INTERIM) INSPECTIONS

Other Special (Interim) Inspections are scheduled by the bridge owner to examine bridges or portions of bridges with known or suspected deficiencies which require monitoring. Other Special (Interim) Inspections tend to focus on specific areas of a bridge where problems were previously reported or to investigate areas where problems are suspected. By definition, Other Special (Interim) Inspections do not fulfill NBIS/NTIS requirements for Routine Inspections. Other Special (Interim) Inspections are structured to fulfill the need for Interim Inspections between the 24-month NBIS/NTIS inspections. Other Special (Interim) Inspections are conducted until corrective actions can remove high priority maintenance recommendations, the component is removed from service, or further study determines conditions are no longer deteriorating at accelerated levels.

2.3.5.2 PURPOSE OF OTHER SPECIAL (INTERIM) INSPECTIONS

Other Special (Interim) Inspections are used to monitor posted bridges; poor, serious and critical condition ratings; bridges with severe scour issues or known high priority maintenance recommendations and fulfill the need for more frequent inspections. Special (Interim) Inspections are intended to satisfy the reduced inspection interval specified for Other Special (Interim) Inspections in Table IP 2.3.2.4-1.

  - 7A03 Primary Type = I
  - Check the data box for 7A06 Other Special (Interim) Inspections.
  - All interim inspection requirements for FCMs as listed in the Fatigue and Fracture Plan (F&F Plan) must be satisfied.
- If not intended to satisfy the reduced inspection interval, use 7A03 = A, B, or P.

If an inspection is not intended to satisfy the reduced interval for Other Special (Interim) Inspection, then the data box for 7A06 Other Special (Interim) Inspections is to be unchecked. These inspections would fall under another inspection type such as Damage or Problem Area Inspections. Underwater inspections by divers, even on a more frequent basis, are always to be coded as Inspection Type 7A03 = U or W.

2.3.5.3 INTENSITY OF OTHER SPECIAL (INTERIM) INSPECTIONS

The level of effort required to perform an Other Special (Interim) Inspection will vary with its purpose and the structure's type, size, design complexity, existing conditions, and type of deficiency being investigated.

When a bridge's condition requires a reduced inspection interval (as per Table IP 2.3.2.4-1), only a portion or portions of the bridge that are in critical condition may warrant more frequent and/or intense inspection to ascertain its safety. For such situations, an Other Special (Interim) Inspection of limited scope for the critical portions is to be used to satisfy the reduced interval requirement and reduce overall inspection cost. The engineer-in-charge of an inspection contract or group of bridges (either consultant or District) is to develop an appropriate scope of work. The District Bridge Engineer must approve the scope of work and interval of Other Special (Interim) inspections to ensure compliance with this manual and for eligibility for federal reimbursement of inspection costs. If the limited scope Other Special (Interim) Inspection has not been authorized, a Routine Inspection is to be performed to fulfill the reduced interval inspection requirement and meet NBIS/NTIS compliance requirements. In this case, the NBIS/NTIS target date will be reset. See IP 2.3.2 for more information on Routine Inspections.

Examples where an Other Special (Interim) Inspection may be utilized on a reduced interval to sufficiently monitor and evaluate deteriorated portions of a bridge in a cost-effective manner include, but are not limited to:

- Inspecting substructure in serious condition due to settlement, but not inspecting the deck and superstructure in satisfactory condition. The stream channel and IR screen items did not need interim inspections.
- Inspecting only the deteriorated ends of a steel stringer bridge that control condition rating and load rating. The satisfactory condition of the deck and substructure do not warrant an interim inspection.

Other Special (Interim) Inspections of Fracture Critical bridges for the reduced interval must address all work items specified for the interim inspections in the Fatigue and Fracture (F&F) Plan. The F&F Plan should identify those FCMs that require hands-on inspection during the interim and provide guidelines and procedures on what to observe and/or measure during the inspection (see IP 2.4.5.1).

Other Special (Interim) Inspections must be performed by a qualified team leader. The personnel performing an Other Special (Interim) Inspection should be familiar with the nature of the known deficiency and its functional relationship to satisfactory bridge performance.

2.3.5.4 INTERVAL OF OTHER SPECIAL (INTERIM) INSPECTIONS

Other Special (Interim) Inspections are scheduled by the noted interval in Table IP 2.3.2.4-1 or more frequently at the discretion of the bridge owner. The determination of an appropriate Other Special (Interim) Inspection interval should consider the nature, severity and extent of the known deficiency, as well as age, traffic characteristics, public importance, and maintenance history.

When a reduced inspection interval is required by Table IP 2.3.2.4-1, check the data box for Other Special (Interim) Inspections in BMS Item 7A07 Required Inspection. Use the interval from Table IP 2.3.2.4-1 to populate 7A09 Frequency for Other Special (Interim) Inspections.

2.3.5.5 ELEMENT-LEVEL DATA COLLECTION FOR OTHER SPECIAL (INTERIM) INSPECTIONS

Element-level data is always collected as part of tunnel inspections including Other Special (Interim) Inspections. For the inspection of bridges and culverts it is generally not required for Other Special (Interim) Inspections. For a reduced interval bridge, it is unlikely that any change in element conditions would be significant enough to have any real impact on the predictive bridge model (the primary purpose of this data) to warrant its collection.

If the owner is required or elects to collect element-level data, provide Condition State data for all inspected elements in BMS2 Items 1A10 and 1A11. This data is to be entered into BMS2 with the other inspection information. Once element-level inspection has been performed and data added to BMS2, "check" the data box for ELEMENT inspection for BMS2 Item 7A06 (Inspection Performed). See IP 2.3 for additional information on element level data collection.

2.3.6 Monitoring of Inspection Interval for NBIS/NTIS Compliance

The NBIS/NTIS require data collection for specific categories of highway bridge inspections which must be monitored for compliance. These inspection categories, called Compliance Inspection Types to differentiate them from the types in BMS Item 7A03, are utilized in BMS2 Inspection Scheduling items 7A06-7A10. The NBIS has four Compliance Inspection Types which include Routine (NBI), Fracture Critical, Underwater, and Other Special (Interim). The NTIS also has four Compliance Inspection Types, but they are Routine (NTI), Damage, In-Depth and Other Special (Interim).

2.3.6.1 RESPONSIBILITY FOR COMPLIANCE

The bridge owner has the primary responsibility to ensure that the individual bridges and structures under their purview are inspected in compliance with the standards as set forth in this Manual. Under the NBIS/NTIS regulations, the Department has a responsibility to ensure that public highway bridges are inspected. To ensure that the bridges and structures are inspected in a timely manner for public safety and for compliance with regulations, the responsibilities for monitoring and ensuring the compliance of safety inspection frequencies are as follows:

- District Bridge Engineer for the following individual structures in their District:
  - Department bridges/structures

  - NBIS/NTIS bridges owned by local municipalities and Counties
  - Non-highway bridges/structures over State Routes
- BIS for the following individual structures statewide:
  - NBIS/NTIS bridges owned by PTC, DCNR, and other state and toll agencies
- BIS for overall statewide compliance of all structures

To facilitate compliance by the owners, the BIS places four spreadsheets on the P-Drive for each District called the Monthly Compliance (M1) Report by the 5th of each month. In addition to the M1, four spreadsheets pertaining to underwater inspection are placed on the P-Drive for each District called the Monthly Underwater Compliance (UW M1) Report. If a District has a tunnel inspection coming due in the next 2 months, there will be an additional spreadsheet placed on the P-Drive folder for the tunnels called Tunnel M1. Emails are sent to the District Bridge Engineer and the Assistant District Bridge Engineer for Inspection as a notification that the spreadsheets have been posted to the P-Drive locations. Separate notifications are sent by the BMS2 Manager to the other state and toll agency bridge owners. Both the M1 and the UW M1 spreadsheets include inspections due in the current month and future months, as well as those due in the prior month as shown below:

- PennDOT NBIS (bridges greater than 20 feet in length)
- PennDOT non-NBIS (<20' bridges)
- Non-PennDOT (local >20' bridges)
- Past Due

The spreadsheet titled "Past Due" is necessary due to the lag in time allowed to upload inspection data to BMS2. In accordance with IP 8.1, the submission of the *i*Forms inspection report is permitted to be submitted 10-days after the field inspection for bridges and 30-days for tunnels. Since some of the prior month's inspection data is inconclusive on the 5th of the month, the District must complete a status of each bridge on the "Past Due" spreadsheet for the actual inspection dates to indicate whether the inspection occurred on-time or late. Similarly, the BMS2 Manager will coordinate completion of the actual inspection dates for bridges owned by other state and toll agencies. The completion of the actual inspection dates in the "Past Due" spreadsheet must be completed 15 days before the end of the month. BMS2 Manager will re-run the "Past Due" spreadsheet 10 days before the end of the month to confirm the completion of the inspections due in the previous month.

There is only one Tunnel M1 spreadsheet which lists all tunnels due in the next three months since the inspections for tunnels are allowed to begin up to two months prior to their next inspection due date.

In addition, the Assistant District Bridge Engineer for Inspection is also required to update the PennDOT NBIS, PennDOT non-NBIS and Non-PennDOT spreadsheets as well as the Tunnel M1 spreadsheet (if applicable) on the P-Drive 15 days before the end of the current month to provide either the actual or planned inspection dates for the current month. The BMS2 Manager is required to coordinate the actual or planned inspection dates for NBIS bridges owned by other state and toll agencies. After reviewing the dates compiled in the spreadsheets, the BMS2 Manager will report all outstanding district responses to the Bridge Inspection Section Chief who will then contact the District Bridge Engineer or the other state and toll agencies to determine whether use of a state-wide open-end inspection agreement is necessary to complete either past due or current inspections. Consultants shall be responsible for submitting monthly schedules and progress updates to each District Bridge Engineer as required by the standard scope of work for bridge inspection agreements.

Annual lists for underwater inspections by divers will be prepared by each District and compiled by the BIS for state, local and other agency bridges. The November UW M1 Report spreadsheets will be used each year and completed by each District and Central Office by the end of January each year. Bridges needing an underwater inspection with a due date between April in the following calendar year and March of the subsequent calendar year will be included with the annual lists to ensure underwater inspections are scheduled and completed within the required interval. Underwater inspections by divers are completed predominately with Central Office statewide engineering agreements and funded by the BIS; the completion of the annual list will also be used to forecast fiscal year budgetary commitments.

In those cases where a structure is due for a Routine Inspection and Table IP 2.3.2.4-1 requires an inspection interval less than 24 months, the coding for Item 7A09 (Inspection frequency) must reflect the reduced interval.

To facilitate the monitoring of compliance of the inspection interval with the maximum 24/48-month interval allowed by NBIS/NTIS and any reduced interval due to bridge conditions, the coding in Table IP 2.3.2.4-1 should be used for BMS2 data item 7A03 (primary inspection type) and 6B20 (next inspection type).

2.3.6.2 TOLERANCES FOR FREQUENCIES OF COMPLIANCE TYPES OF INSPECTION

The tolerance allowed for variations between the actual interval and the required interval for each inspection type will be measured in months with the schedule based on the last NBI/NTI inspection, as listed below. Bridges inspected within the tolerances listed below will be considered "on time" and compliant with required inspection interval.

NBI Inspections - The 24/48 month interval is a regulatory requirement and no tolerance is allowed.

- Bridges inspected month(s) earlier re-set the NBI date. Subsequent inspection intervals will be based on the last "early" inspection and required interval.
- If the regularly scheduled NBI inspection is to occur when the bridge is under repair or rehabilitation, refer to FHWA Questions and Answers on the NBIS 23 CFR 650 Subpart C https://www.fhwa.dot.gov/bridge/nbis/.
- For unusual circumstances, a 1-month delay may be allowed. Documentation of the reason for delay must be outlined in the inspection notes and the BIS must be notified.

NTI Inspections - The 24-month interval is a regulatory requirement, however NTIS allows a tolerance = +/- 2 months (before or after) scheduled month.

- Tunnels are not to be inspected prior to the two-month tolerance without written approval from FHWA and PennDOT.
- If the regularly scheduled NTI inspection is to occur when the tunnel is under repair or rehabilitation, the next NTI inspection shall occur after all construction is complete and systems are tested, but prior to opening the tunnel to traffic.

Other Special (Interim) Inspections - The interval tolerance varies with the required Other Special (Interim) Inspection frequency 7A09:

- Required frequencies of 12 or 24 months: Tolerance = +/-1 month (before or after) scheduled month.
    - This tolerance is allowed to provide greater flexibility.
    - Efforts should be made to maintain 12-month interval when possible.
- Required interval < 12 months: No tolerance allowed.

Fracture Critical Inspections - If included as part of NBI inspection – no tolerance.

- For Fracture Critical inspections done as part of Other Special (Interim) inspections, the same tolerance (+/-1 month) allowed for Other Special (Interim) Inspections will apply.

Underwater Inspections – The interval tolerance varies with the required UW Inspection frequency 7A09:

- Required 60 months interval: This is a regulatory interval - No tolerance allowed.
- Required interval of 24 months: Tolerance = +/-1 month (before or after) scheduled date.
- Required interval of 12 months: Tolerance = -1 month (before) scheduled date.

Damage and In-Depth Inspections – NTI does not monitor the inspection interval for Damage and In-Depth Inspections.

2.3.6.3 TRACKING DATA FOR INSPECTIONS COMPLETED FOR NBIS/NTIS

Table IP 2.3.6.6-1 indicates the appropriate values for Item 7A06 Inspection Performed for the 7A03 Primary Inspection Type and the interval of inspection for bridges and miscellaneous structures. For tunnels, this information is located in Table IP 2.3.6.6-2. To facilitate the monitoring of compliance of the inspection interval with the 24/48-month NBI/NTI interval and any reduced interval Other Special (Interim) Inspections due to bridge conditions, the coding values shown in these tables should also be used for BMS2 data 6B20 Next Inspection Type.

2.3.6.4 COMPLIANCE MONITORING DATA

Bridge owners are to utilize the Inspection Scheduling data fields on the BMS2 Ratings and Schedule screen to document the completion of the various inspection types required by the NBIS/NTIS regulations and Department policy. The Department uses the Inspection Scheduling data fields to report required information to the NBI/NTI and to monitor inspection interval compliance. Additional guidance for this data may be found in Publication 100A Inspection Scheduling Items 7A06-7A10 and Item1A09 – Inspection Status.

Table IP 2.3.6.4-1 lists the Compliance Inspection Types for NBIS and NTIS and indicates how they are reported to the NBI/NTI. BMS2 automatically populates NBI items 90-93 for the annual report to FHWA during the NBI Extract process when the BMS2 Scheduling data for items 7A06-7A09 is correctly coded. Not all of the 7A03 Inspection Types are applicable to the NBI/NTI; therefore, not all inspection types are reported to FHWA. Similarly, BMS2 automatically populates D.2 through D.6 for tunnels for the NTI annual report.

Table IP 2.3.6.4-1 Compliance Inspection Types and Applicable 7A03 Types for NBI/NTI Extract File

Compliance Inspection Types	Category Description	Applicable 7A03 Types	NBI/NTI Items computed from BMS Data *		
			Req'd 7A07	Freq 7A09	Insp Date 7A01/7A08***
NBIS Compliance Inspection Types (Bridges and Culverts)					
NBI	National Bridge Inventory Inspection	R, C, F, W	**	91	90
FC	Fracture Critical Inspection	R, C, F, I, W	92 A	92 A	93 A
UW	Underwater Inspection by Divers	U, W, F	92 B	92 B	93 B
OS	Other Special (Interim) Inspection	I, R, C, W	92 C	92 C	93 C
NTIS Compliance Inspection Types (Tunnels)					
NTI	National Tunnel Inventory Inspection	R, F	**	D.3	D.2
	Damage Inspection	B	D.5	◊	◊
	In-Depth Inspection	D	D.4	◊	◊
OS	Other Special (Interim) Inspection	I	D.6	◊	◊

* NBI Items are described in the SI&A Coding Manual. NTI Items are described in the SNTI.
** Required for all NBIS/NTIS structures as applicable - no separate data item is provided.
*** The more recent of 7A01 or 7A08 is reported to NBI
◊ Not captured by NTI

2.3.6.5 INSPECTIONS REQUIRED BY NBIS/NTIS

A summary of the Compliance Inspection Types required by the NBIS and NTIS are listed in Table IP 2.3.6.4-1. BMS2 uses Item 7A07 Required Inspections to initiate compliance monitoring for the individual bridges.

NOTES on 7A07 Required Inspection:

- The 7A07 Required Inspection is key for other compliance monitoring data.

- If 7A07 does not indicate "REQUIRED" for an inspection type, BMS2 does not update 7A08 Last Inspection and it does not report that inspection type with the NBI/NTI.
- If that inspection type is required by policy and the 7A07 data box is improperly unchecked for that type, the bridge would be non-compliant with NBIS/NTIS based on the 7A08 data.

▪ Once entered into BMS2, Item 7A07 for the compliance inspection types is copied by BMS2/*i*Forms for the subsequent inspections.
  - The engineer-in-charge should revise 7A07 and 7A09 after an inspection has determined that bridge conditions have changed sufficiently to warrant their revision.
  - NOTE: Having 7A07 data box checked to indicate a required Compliance Type Inspection does not necessarily mean that each required inspection type must be performed for every inspection. The required types of inspection due at each inspection will be governed by the interval specified in 7A09.

▪ For NBI/NTI bridges with a reduced inspection interval, enter the intervals for 7A07 NBI and 7A07 Other Special (Interim) Inspection as listed in Table IP 2.3.2.4-1.
  - This will correctly result in occasions where NBI/NTI and Other Special (Interim) Inspection are both due (i.e., every other year for an Other Special (Interim) Inspection interval of 12 months). For these "dual due dates", perform an NBI/NTI inspection and check the 7A06 data boxes for <u>both</u> NBI/NTI and Other Special (Interim) Inspection.

Table IP 2.3.6.5-1 Compliance Inspection Types Required for NBIS and 7A07 Req'd Inspection Data

Compliance Insp Types	**Req'd 7A07***	**Compliance Inspection Type required when:**	**See Also**	**Frequency 7A09**
NBI	**	NBIS Indicator (BMS2 Item 5E01) = Y	IP 2.3.2	Table IP 2.3.2.4-1
FC	☑ or ☐	Bridge has Fracture Critical Members (FCMs) (BMS2 Item 6A44 ≤ 4)	IP 2.4	With NBI or Other Special (Interim) Inspection
UW	☑ or ☐	Inspection by UW divers is needed to ascertain bridge substructure and/or foundation condition.	IP 2.6	Table IP 2.6.2.4-1
OS	☑ or ☐	A reduced interval (< 24 months) inspection is required.	IP 2.3.2 IP 2.3.5	Table IP 2.3.2.4-1

*7A07 checked box ☑ = Required, unchecked box ☐ = Not required
** There is no 7A07 NBI data box – All bridges require NBI inspections

2.3.6.6 FREQUENCIES FOR COMPLIANCE INSPECTION TYPES

The NBIS/NTIS requires the Compliance Type Inspections to be performed on a regular interval. Table IP 2.3.2.4-1 provides information on interval to be entered into BMS2 Item 7A09. For frequencies for Underwater Inspections see Table IP 2.6.2.4-1. The owner may elect to perform inspections more frequently than required. Authorization for longer frequencies must be requested from BIS and FHWA.

Table IP 2.3.6.6-1 Inspection Type (7A03) and Inspection Performed (7A06) – Not Tunnels

Insp types also applicable to 6B20		Meets requirements		Checkboxes for 7A06 Inspection Performed					7A06 Coding – See Examples in Pub 100A ☑ Performed – Check box of inspections performed ☐ Not Performed– Uncheck the box ▣ CHECKED/UNCHECKED, AS PERFORMED If performed, check the box. ☑ If NOT performed, uncheck the box. ☐
		NBI	OS						
7A03	Primary Inspection Type**	24/48 month	≤ 24 months	NBI	FC	Underwater	Oth. Special	Element	
SECTION 1 NBIS Compliance Inspection Types (See IP 2.3.2.5)									
R	**Routine**	YES	YES	☑	▣	☐	▣	▣	– **NBI Inspection#** – Must include hands-on for FCMs as per Fatigue & Fracture (F&F) Plan – Other Special (Interim) Inspection also checked when this inspection type is used to satisfy reduced interval – May include element insp., probing of substructure
C	**Routine Using Crane**	YES	YES	☑	▣	☐	▣	▣	– **NBI Inspection#** – A complete routine inspection of bridges where the inspection crane is utilized – Other Special (Interim) Inspection also checked when this inspection type is used to satisfy reduced interval – Must include hands-on for FCMs as per F&F Plan
I	**Other Special (Interim)**	NO	YES	☐	▣	☐	☑	▣	– **NOT an NBI Inspection#** – Use ONLY to meet reduced interval for Other Special (Interim) Inspections – Must include hands-on for FCMs as per F&F Plan – If UW is performed, add separate inspection 7A03.
F	**Initial (1st Time)**	YES	Not Appl.	☑	▣	▣	☐	▣	– **NBI Inspection#** – 1st time inspection of new or re-constructed bridge – Must include hands-on for FCMs as per F&F Plan – 48-month NBI interval does not apply to Initial (First Time) Inspection type.
U	**Underwater Only (DIVERS)**	NO	NO	☐	☐	☑	☐	☐	– **NOT an NBI Inspection#** – Meets NBIS requirements for UW Inspection only – Stand-alone underwater inspection by DIVERS – Add a separate inspection 7A03 = I if the OS(I) scope extends beyond the "underwater only" inspection
W	**Routine with Underwater (DIVERS)**	YES	YES	☑	▣	☑	▣	▣	– **NBI Inspection#** – Meets requirements of Routine Inspection – Includes underwater inspection by DIVERS – Must include hands-on for FCMs as per F&F Plan – Other Special (Interim) Inspection also checked when this inspection type is used to satisfy reduced interval
SECTION 2 Additional Inspection Types (highway bridges, not including tunnels)									
A	**Access Equipment Only**	NO	NO	☐	☐	☐	☐	☐	– **NOT an NBI Inspection#** – Limited inspection with special access equipment – If used to meet reduced interval of Other Special (Interim) Inspections, set Inspection Type 7A03 = I
B	**Damage**	NO	NO	☐	☐	☐	▣	☐	– **NOT an NBI Inspection#** – Limited to damaged elements – **If used to meet reduced interval of Other Special (Interim) Inspections, set Inspection Type 7A03 = I or U if completed by divers** – Check the 7A06 and 7A07 boxes for Other Special when initiating a newly required reduced inspection interval – Typical uses: Collision damage and post-flood

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****7A03 Inspection Types R, C, F, U, W, B, & P may also be used for 8'-20' bridges (non-NBIS length)**

 # Record crane or equipment use on the Inspection Planning Screen in BMS2

Table IP 2.3.6.6-1 Inspection Type (7A03) and Inspection Performed (7A06) – Not Tunnels

Insp types also applicable to 6B20		Meets requirements		Checkboxes for 7A06 Inspection Performed					7A06 Coding – See Examples in Pub 100A ☑ Performed – Check box of inspections performed ☐ Not Performed– Uncheck the box ▣ CHECKED/UNCHECKED, AS PERFORMED If performed, check the box. ☑ If NOT performed, uncheck the box. ☐
		NBI	OS						
7A03	Primary Inspection Type**	24/48 month	≤ 24 months	NBI	FC	Underwater	Oth. Special	Element	
D	**In-Depth**	NO	NO	☐	▣	☐	☐	▣	– **NOT an NBI Inspection#** – Inspection limited to portions of bridge. – If Inspection scope suffices for NBI inspection, code Inspection Type 7A03 = R, C, or W – If used only to meet a more frequent Other Special (Interim) Inspection, set Insp. Type 7A03 = I
E	**Element Inventory Only**	NO	NO	☐	☐	☐	☐	☐	– **NOT an NBI Inspection#** – Inventory only of element level data.
G	**Fracture Critical**			☐	☐	☐	☐	☐	– **NOT AVAILABLE FOR NEW INSPECTIONS** – Maintained for historical information only of code identification from superseded BMS AJ screen.
P	**Problem Area**	NO	NO	☐	☐	☐	☐	☐	– **NOT an NBI Inspection#** – One-time inspection limited to critical area(s). – **Do NOT use to meet or initiate a reduced interval. For reduced interval set 7A03 = I**
Z	**Inventory Only**	NO	NO	☐	☐	☐	☐	☐	– **NOT an NBI Inspection#** – Used for inventory all bridges and other structures.
SECTION 3 Additional Inspection Types (non-highway bridges and structures, not including tunnels)									
H	**Highway Environs Only**	NO	NO	☑	☐	☐	▣	☐	– Inspection of non-highway bridges/structures over highways. Inspection limited to highway environs. #
L	**High Mast Light Poles**	NO	NO	▣	☐	☐	▣	☐	– Add “checkmark” to 7A06 NBI only if IS01 = A or D which are NBI-like Inspection of high mast light poles, their foundations, anchor bolts and other components. #
M	**Miscell-aneous**	NO	NO	☑	▣	▣	▣	☐	– NBI-like inspection of other miscellaneous structures NOT over highways, pedestrian, or rail bridges. #
O	**Overhead Non-Highway**	NO	NO	☑	▣	☐	▣	☐	– NBI-like inspection of structural components of overhead non-highway bridges. #
S	**Sign Structure**	NO	NO	▣	▣	☐	▣	☐	– Add “checkmark” to 7A06 NBI only if IS01 = A, B, C, or D which are NBI-like inspection for sign structures. #
T	**Retaining and Noise Wall**	NO	NO	▣	▣	☐	▣	☐	– Add “checkmark” to 7A06 NBI only if IW01 = F, R, or D which are NBI-like inspection for retaining walls and noise walls. #
X	**Unknown**	NO	NO	☐	☐	☐	☐	☐	Generally, this applies to an errant record only. # ***TABLE PAGE 2 OF 2***

****7A03 Inspection Types R, C, F, U, W, B, & P may also be used for 8’-20’ bridges (non-NBIS length)**

 # Record crane or equipment use on the Inspection Planning Screen in BMS2

Table IP 2.3.6.6-2 Inspection Type (7A03) and Inspection Performed (7A06) - Tunnels

Insp types also applicable to 6B20		Meets requirements NTI	Meets requirements OS	Checkboxes for 7A06 Inspection Performed					7A06 Coding – See Examples in Pub 100A ☑ Performed – Check box of inspections performed ☐ Not Performed– Uncheck the box ▣ CHECKED/UNCHECKED, AS PERFORMED If performed, check the box. ☑ If NOT performed, uncheck the box. ☐
7A03	Primary Inspection Type	24-month	≤ 24 months	NBI (NTI)	Fract. Crti.	Underwater	Oth. Special	Element	
NTIS Compliance Inspection Types (See IP 2.3.2.5)									
R	**Routine**	YES	YES	☑	☐	☐	▣	☑	– **NTI Inspection#** – Other Special (Interim) Inspection also checked when this inspection type is used to satisfy reduced interval – All tunnel inspections qualify as element level
F	**Initial (1st Time)**	YES	Not Appl	☑	☐	☐	☐	☑	– **NTI Inspection#** – 1st time inspection of new or re-constructed tunnel – All tunnel inspections qualify as element level
I	**Other Special (Interim)**	NO	YES	☐	☐	☐	☑	☑	– **Not an NTI Inspection#** – Use ONLY to meet reduced interval for Other Special (Interim) Inspections – All tunnel inspections qualify as element level
B	**Damage**	NO	NO	☐	☐	☐	▣	☑	– **Not an NTI Inspection#** – Limited to damaged elements or systems – **If used to meet reduced interval of Other Special (Interim) Inspections, set Inspection Type 7A03 = I** – Check the 7A06 and 7A07 boxes for Other Special when initiating a newly required reduced inspection interval – Typical uses: Collision damage – All tunnel inspections qualify as element level
D	**In-Depth**	NO	NO	☐	☐	☐	▣	☑	– **Not an NTI Inspection#** – Inspection limited to portions of bridge. – If Inspection scope suffices for NBI inspection, code Inspection Type 7A03 = R, C, or W – If used only to meet a more frequent Other Special (Interim) Inspection, set Insp. Type 7A03 = I All tunnel inspections qualify as element level

 # Record special equipment use on the Inspection Planning Screen in BMS2

2.4 FRACTURE CRITICAL INSPECTIONS

2.4.1 General

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 fracture critical inspections be performed to identify these potential failures before they occur.

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 in metal: tensile stresses, repetitive loading, and poor details that create high tensile stress concentrations. It is imperative that a fatigue crack is not left unchecked because it may propagate to a size that would trigger fracture. Fracture is the sudden failure by cracking of a member.

As stated in the NBIS, a "fracture critical member (FCM) 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." Tension elements of a bridge member consist of those portions of a flexural (bending) member that are subject to tension or reversal stress. Fatigue is the primary cause of failure in FCMs.

This section provides guidance for identification, classification, recordation, and inspection prioritization of bridges containing fatigue sensitive details and/or fracture critical members, and a basis for determining inspection interval.

The NBIS requires that all bridges with FCMs receive a hands-on inspection of FCMs on an interval not to exceed 24 months. These Fracture Critical Inspections must be recorded in the NBI file submitted to FHWA – this recordation is to be accomplished through the required BMS2 data (see IP 2.3.6).

2.4.2 Purpose of Fracture Critical Inspections

The purpose of a Fracture Critical Inspection is twofold:

- Identify and record the location of fatigue and fracture 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.

- Conduct a hands-on inspection of the complete FCMs, details, and connections to identify and record the location of fatigue prone and fracture prone details and to identify section loss, deterioration or other conditions that may affect bridge safety and performance.

Fracture Critical Inspections meet the NBIS requirements. The term "fracture" is included in the name to encompass those bridges which have fracture-prone details but may not have FCMs. An example of one fracture-prone detail is a multi-girder bridge with wind bracing attached with tri-axial intersecting welds – such a detail caused the Hoan Bridge in Wisconsin to fail in December 2000.

2.4.3 Inventory of Fracture Critical Bridges

The NBIS (§650.313(e)) requires the individual in charge of the bridge inspection organizational unit to:
- Determine and designate on the individual inspection and inventory records those bridges which contain fracture critical members.
- Maintain a master list of the location and description of such members on the bridge and the inspection interval and procedures for inspection of such members.

To meet those NBIS requirements, the Department developed five BMS2 Items (6A44-6A48) to identify and classify bridges with FCMs so that this required "Master List of Bridges with FCMs" could be maintained in the BMS2 to assist in the inspection management of these bridges. In addition, the Department developed the BMS2 6A and IF Screens, "Agency Bridge" and "Inspection - Fracture Critical", to record a summary of FCM inspection findings on each bridge with FCMs to assist the Districts and other bridge owners to have a snapshot of these critical bridge elements. The data in the 6A and IF Screens should be more fully documented in the bridge inspection reports.

All NBIS bridges with FCMs, regardless of ownership, are to maintain inventory and inspection information in BMS2 through the use of the BMS2 Items (6A44-6A48), the 6A Screen, IF Screens and the Bridge Inspection Scheduling data (7A06-7A10).

The Districts are to monitor their inspection reports and those of local bridge owners to ensure these requirements for the inventory and inspection data for FCMs are met.

2.4.4 Classification of Fracture Critical Members

Fracture critical bridges may be classified into 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, collapses. Stated differently, fracture critical bridges are non-redundant structures. The other types of redundancy, Structural redundancy and Internal (or Member) redundancy, help to determine the criticality of non-redundant (or fracture critical) structures.

2.4.4.1 LOAD PATH REDUNDANCY

A main load-carrying member represents a structure's load path. A bridge with four or more load paths is said to have redundant load paths and is defined as a redundant structure. Structures with load path redundancy are not fracture critical. A bridge with three load paths requires structural analysis to determine if it has load path redundancy. A bridge with only one or two load paths is defined as a non-redundant load path structure and is considered fracture critical. See AASHTO Guide Specifications for Analysis and Identification of Fracture Critical Members and System Redundant Members for additional information.

2.4.4.2 STRUCTURAL REDUNDANCY

Bridge structural types that provide continuity of load path from span to span are referred to as structurally redundant. A fracture critical bridge with no structural redundancy is more critical (susceptible to failure) than a fracture critical bridge with structural redundancy. Structural redundancy provides a mechanism to prioritize or rank fracture critical bridges. It is not appropriate to apply the concept of structural redundancy to bridges with load path redundancy (i.e., non-fracture critical bridges).

2.4.4.3 INTERNAL REDUNDANCY

Internal redundancy exists when a bridge member contains several elements bolted or riveted together so that multiple local (internal) load paths are formed. Failure of one member element would not cause total failure of the member. Internal redundancy is also known as "member" redundancy. A built-up riveted plate girder is an example of a member with internal redundancy. Like structural redundancy, internal redundancy provides a mechanism to prioritize or rank fracture critical bridges. It is not appropriate to apply the concept of internal redundancy to bridges which are load path redundant. For additional information on internal redundancy, see AASHTO Guide Specifications for Internal Redundancy of Mechanically-Fastened Built-Up Steel Members.

2.4.4.4 FRACTURE CRITICAL GROUP NUMBER – BMS2 ITEM 6A44

The inspection engineer is to classify each NBIS bridge according to its fracture critical nature in accordance with Table IP 2.4.4.4-1. Group 1 bridges are more fracture critical than Group 2. Group 2 is more critical than Group 3, and so on.

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Table IP 2.4.4.4-1 Coding for BMS2 Item 6A44 Fracture Critical Group Number		
FRACTURE CRITICAL GROUP	**STRUCTURE TYPE**	**FCM**
1	1-girder bridge	Entire girder tension zone
	2-girder bridge w/ simple span	Girder tension zone
	2-girder bridge w/ suspended span	Suspended hanger assembly & girder tension zone
	Truss w/simple span	Tension member (including eye-bar if 2 or less)
	Truss w/ suspended span	Suspended hanger assembly, tension members & certain diagonals
	Tied arch	Tension tie
	Cross-girder pier cap	Tension zone
	Suspension bridges	Eye-bar (2 or less) chain or cables
2	Continuous 2-girder	End span girder tension zone
	Continuous truss	Tension member (including eye-bar if 2 or less)
	Rigid frame steel pier	Tension zone
3	Continuous 2-girder	Interior span girder tension zone
4	3-girder bridge w/suspended span	Suspended hanger assembly & girder tension zone
	3-girder bridge w/simple span	Girder tension zone
	3-girder bridge w/continuous span	Girder tension zone
5	4 or more girder bridges (welded or riveted built up girders, rolled beams with full or partial cover plates, etc.)	None
6	Multi-stringer rolled beam bridges	None
7	Reserved – Do not use	
8	Reserved – Do not use	
9	All other non-steel bridges (Reinf. Concrete, P/S Concrete, Timber, CMP culverts, etc.) and All Tunnels	None

NOTE: Shading indicates non Fracture Critical bridge types

2.4.4.5 CRITICAL RANKING FACTOR (CRF) OF FCM

A numerical index, the Critical Ranking Factor (CRF), is used to prioritize the bridges within each of the fracture critical groups. The CRF is the sum of four digits that characterize the FCM. Each FCM will receive a CRF. The lowest member CRF controls the bridge's CRF. It is not appropriate to calculate Critical Ranking Factors for redundant structures. Stated differently, do not calculate a CRF for a non-fracture critical bridge.

The four components of the most critical FCM are to be entered into BMS2 in Items 6A45-6A48 (see Publication 100A, BMS2 Items 6A45-6A48). The four components of the CRF are described below:

2.4.4.5.1 Type of Member – CRF First Digit

The type of member is ranked by criticality based on judgment as to its use within a structure. Direct tension members, even if they may have no welding associated with them, are the most critical. Eyebars and hangers that have been repaired by field welding are highly susceptible to fatigue cracking and should be placed at the top of the list of structures with these members.

The next most critical members are subject to bending stresses and have been welded in the tension zone. Many of the problems being discovered on in-service bridges are associated with weld terminations or defects that are inherent to the welding process. Welds made in the field are especially susceptible to fatigue cracking. Even tack welds could initiate cracking under certain conditions.

Although members with bolted or riveted connections and members of plain rolled shapes are not immune from defects, field experience shows a very low record of failure due to fatigue cracking. Members of this type are least critical.

2.4.4.5.2 Fatigue Crack Susceptibility – CRF Second Digit

This portion of the CRF determination is intended to assess the criticality of the "as fabricated" or retrofitted condition of the member as it exists in the field today. It closely parallels the allowable fatigue stress determinations contained in AASHTO LRFD Bridge Design Specifications, as used for new designs. The assumption is made that the lower the fatigue stress limit of a member, the more critical the member is. The AASHTO fatigue Category E' details are the most critical and have a ranking factor of one. Plain, unblemished steel plates, or rolled shapes, are fatigue Category A and are assigned a ranking factor of 6. Needless to say, any defects such as section loss due to corrosion or flaws discovered through the bridge safety inspection would immediately change the ranking factor to a one, even for a rolled member, until the defect is adequately repaired.

Because welding process and procedure controls are more difficult in a field welding situation, all field welds, repairs, or attachments, should be given a ranking factor of one.

Any member with details subject to out-of-plane distortion induced fatigue cracking will be given a factor of 1. (Examples: Tie-plates for girder or floor beam brackets, web plates where transverse connection plates are not rigidly attached to the girder, flanges at cross-frames, etc.).

2.4.4.5.3 Material – CRF Third Digit

Welding of steel structures had a major influence on the ultimate safety of a steel tension member. Although steel may have an inherent flaw that could reduce the service life of the member, the majority of defects discovered on in-service bridges that could propagate to catastrophic failure are related to welding. This influence shows up in three ways:

1. Poor quality welding has inherent defects that initiate cracking.
2. Welded attachments create stress raisers that initiate and propagate cracking due to cyclic (fatigue) loading.
3. Welding of "non-weldable" steels or improper weld procedures creates a "brittle" condition, and if located in a single-stress-path member can fail catastrophically by unstable crack growth with little or no advance warning.

Items 1 and 2 above become apparent when visible cracks appear in the member. Ideally, the material properties will exhibit sufficient elastic or plastic deformation (stable crack growth) to allow crack detection and retrofit to take place prior to unstable crack growth and collapse. When Item 3, a brittle condition, exists in conjunction with either poor quality welding and/ or fatigue sensitive details, a "super-critical" condition may exist warranting special in-depth and frequent inspections.

Since the weldability of steel is not apparent without a chemical analysis, use the "Year Built" (BMS2 Item 5A15) as a preliminary indication as to criticality. Although steels used prior to the introduction of "weldable" steels may have had chemical properties suitable for welding, the inspector should assume "non-weldable" steel unless design plans are available, or a chemical analysis is performed indicating a weldable grade. Generally, eyebars were manufactured to the same specification as structural steel, so these comments apply to eyebars, plates and rolled sections.

In the absence of a chemical analysis, use the material characteristics from Table IP 2.4.4.5.3-1.

Table IP 2.4.4.5.3-1 Material Properties for Coding CRF Digit -3 Without Chemical Analysis			
Year Built	**Primary Fabrication Process**	**Probable Grade of Steel**	**Weldable**
Before 1957	Riveted (See Note Below)	A7, A8, A94, or A242	No
1957 – present	Riveted (See Note Below) or Bolted or Welded	A7, A8, or A94	No
1957 – present	Riveted (See Note Below) or Bolted or Welded	A373 or A242 Weldable	Yes
1965 – present	Riveted (See Note Below) or Bolted or Welded	A36, A441, or A242	Yes
1965 – present	Riveted (See Note Below) or Bolted or Welded	A7, A440, A8, or A94	No
1965 – present	Welded or Bolted	A36, A572, or A588	Yes
1965 – present	Welded or Bolted	A514 or A517	Yes
Note: Specifications allowed welding of secondary members and miscellaneous details			

Further, steel can have a chemistry suitable for welding but still exhibit low values of toughness as indicated by Charpy 'V' notch (CVN) testing. If CVN data is available, and it is above 15 ft/lb at 40° F, then a ranking factor of 2 or 4 is appropriate. Otherwise, a 1 or 3 should be assigned dependent upon weldability determination. A514/A517 steel (90,000+ psi yield strengths) has exhibited low toughness values in field situations. Therefore, even though it is a weldable grade, a factor of 3 should be assigned for all A514/A517 steel. For important Fracture Critical bridges where the toughness properties are not known, Charpy V Notch tests are recommended to better establish this key information.

Fracture critical members designed since 1977, should have been fabricated in accordance with a fracture control plan (FCP). If the FCP was used, a factor of 4 (except for A514/A517) is appropriate assuming no unauthorized field welds are discovered.

2.4.4.5.4 Cumulative Truck Traffic – CRF Fourth Digit

Although truck traffic is not always the cause of fatigue cracking, without question it is the predominant influencing factor. Therefore, routes that have been, or will be, subjected to high truck volumes are highly susceptible to fatigue cracking and will be assigned a factor of 1. The CRF 4th Digit can be determined by using Table IP 2.4.4.5.4 -1. Use the estimated remaining fatigue life if available. If cumulative truck traffic is not available or cannot be estimated reasonably, the following code based on the Average Daily Truck Traffic (ADTT) may be used:

Table IP 2.4.4.5.4 -1 Coding for Cumulative Truck Traffic for CRF		
CRF 4th Digit	**Known Remaining Fatigue Life**	**ADTT**
1	< 10 Years	> 2000
2	11 - 20 Years	1000 – 2000
3	> 20 Years	< 1000

2.4.5 Components of Fracture Critical Inspections

Fracture Critical Inspections look specifically at details that are susceptible to fatigue and/or fracture. Key components of Fracture Critical Inspections are:

- Fatigue and Fracture Plan
- Field Inspection Results, including testing
- Bridge Analysis and Computation of Remaining Fatigue Life
- BMS2 data (6A26-6A29, 6A44-6A48, 6A and IF Screens)
- BMS2 Inspection Scheduling data (7A06-7A10) – used for NBIS compliance tracking.

The inspection engineer has to determine how each of these components are applied to individual bridges in order to properly monitor the fatigue and fracture prone details on the bridge so as to recognize, from field observations, when the conditions have changed and take appropriate actions.

2.4.5.1 FATIGUE AND FRACTURE PLAN

The Fatigue and Fracture (F&F) Plan is a key first step in performing a thorough and complete investigation of the threat of fatigue and/or fracture to the bridge. It provides a "map" of FCMs and their details on the structure to identify all fatigue prone or fracture critical details for the inspectors. This assures that the conditions at all critical components will be inspected adequately and the field results presented in an organized manner to enable the inspection engineer to ascertain the bridge's safety in a timely manner.

The F&F Plan must be included as part of the bridge file. It provides a method for establishing and monitoring the history of the behavior of fatigue and fracture prone details on a fracture critical structure. It should also identify methods of access required for the inspection. Appendix IP 02-H includes a blank cover page which shall be utilized on all F&F Plans. An excel version of this form along with a completed sample is available on the BMS2 home screen under the PennDOT Bridge Inspection Forms and Templates link.

A F&F Plan shall include the following:

- Sketch(es) of superstructure with locations of all fatigue and fracture prone details identified
  - Use grid diagram (framing plan) with detail locations labeled by letters or numbers and a legend explaining the number or letter scheme.
  - Use an elevation view for truss
  - Classify similar fatigue/fracture prone details as "types" (e.g. end of partial cover plate)
- A table of fatigue/fracture prone details indicating
  - Type of detail (e.g. end of partial cover plate, short web gap, etc.)
  - Location of each occurrence of detail
  - AASHTO Fatigue Category of detail
  - Identify retrofits previously installed
  - Table can be organized by Span or type of detail
- Specific instructions for a limited scope Other Special (Interim) Inspection used to satisfy a more frequent inspection interval.

For bridges with FCMs, the following documents are to be stored in the BMS2 Documents link, in addition to any hard copies maintained in the owner's permanent bridge file:

- Fatigue and Fracture Plan
- Design and Shop Drawings for Superstructure (when available)
- Fatigue Computations (when available)

Bridges with concrete-encased FCMs pose a special challenge to bridge inspection. The F&F Plans for such structures are to contain bridge-specific instructions for inspection to:

- Identify portions of encased FCMs of higher susceptibility to fracture or fatigue.
  - Where encasement is fully intact, visual observation alone may be used on an interval not to exceed 24 months when it will sufficiently ascertain the FCM condition.
  - Where encasement is not intact, hands-on inspection is warranted.
- Identify portions of encased FCMS with lesser susceptibility to fracture or fatigue.
  - Visual observation alone may be used on an interval not to exceed 24 months if it will sufficiently ascertain the FCM condition. Otherwise, hands-on inspection is required.
- Identify portions of encased FCMs that do not warrant hands-on inspection.
- Provide photos to document condition of concrete encasement, especially at fatigue or fracture-prone details, for F&F Plan. Update photos during subsequent inspections.
- Provide for testing (via sounding, etc.) of encasement integrity in critical locations on an on-going basis.

Submit F&F Plan of bridges with encased FCMs to the BIS for review and comment in conjunction with FHWA. Without an approved F&F Plan noting special inspection instructions, a full hands-on inspection is required (see IP 2.4.6).

2.4.5.2 FIELD INSPECTION RESULTS

The condition of each FCM inspected should be noted in the field documentation. While noting any cracking, section loss, or deterioration is essential, a documented finding of "no cracking" or "no section loss" in a Fracture Critical detail also helps the engineer track the overall condition of the bridge. The D-450 inspection forms and *i*Forms generally need to be augmented with additional note sheets. Photos and sketches, properly referenced to field notes, are also part of a good Fracture Critical Inspection.

The results of the field inspection should be carefully documented and compiled in accordance with the F&F Plan, again to assist in tracking the condition of the various details.

2.4.5.3 BRIDGE ANALYSIS AND COMPUTATION OF REMAINING FATIGUE LIFE

Knowledge of the stress level that an FCM detail is subjected is an important key to establishing the criticality of the detail and estimating its remaining fatigue life. See the Department's DM4 Policies and Procedures Section 5.1 for the method of calculating remaining life.

2.4.5.4 BMS2, *i*FORMS, AND FRACTURE CRITICAL INSPECTIONS

The findings of the Fracture Critical Inspection should be summarized on the BMS2 Fracture Critical (IF) screen using the *i*Forms D-450 F form to facilitate NBIS requirements and to provide a synopsis for the engineer in charge to plan needed follow-up actions. Entries are required for all fracture critical members, details, and connections.

Examples include:
- Lower chord members in trusses
- Connection gusset plates framing tension members
- Verticals, diagonals and counters in tension
- Floorbeams in trusses and two-girder or three-girder bridge systems spaced greater than 14' or meeting the requirements outlined in the BIRM
- Fatigue prone details
- Upper chord members in continuous trusses
- Pin and Hangers (with or without catcher beams)

Whenever a Fracture Critical inspection is required, items 7A07 (Required inspection) and 7A09 (Inspection frequency) must be checked and the interval entered respectively.

2.4.6 Intensity of Fracture Critical Inspections

Fracture critical members require a hands-on inspection of FCMs, details and connections to discover cracking, section loss and deterioration. The inspector should plan to have proper access to reach the members 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.

Fracture Critical Inspections are to be a component of a Routine Inspection or an Other Special (Interim) Inspection. It may also be a stand-alone In-Depth Inspection or Problem Area Inspection. The engineer-in-charge should determine the intensity of the inspection for each FCM detail. Factors for consideration include criticality of detail, tension stress level, overall member condition, estimated remaining fatigue life of detail, ADTT, retrofits, etc.

When a reduced interval is required by Table 2.3.2.4-1, a hands-on re-inspection of all FCMs is required unless an F&F plan designates those FCM's that require inspection as part of a limited scope Other Special (Interim) Inspection. The F&F Plan must document that the proposed Other Special (Interim) Inspection would include hands-on inspection of the portions of the FCMs that necessitate the reduce interval, namely:

- Those FCMs in poor or worse condition having advanced or serious sections loss.
- FCMs with a load capacity at Safe Load Capacity (SLC) level that is less than legal loads.

For the other FCMs on the bridge, the engineer may detail in the F&F Plan those FCMs (or portions thereof) that do not require hands-on inspection during Other Special (Interim) Inspections. The scope of a limited Other Special (Interim) Inspection must be in the F&F Plan and approved by the District Bridge Engineer.

Concrete-encased FCMs are to be inspected with other FCMs on a bridge. However, when the encasement is intact, hands-on inspection may not greatly add to information garnered by careful observation during a non-hands-on visual inspection. Accordingly, some adjustment to the F&F Plan for these concrete-encased FCMs may be appropriate and is to be addressed in the F&F Plan. Concrete-encased FCMs of higher susceptibility to fracture or fatigue may include: those with details of fatigue Category D or higher (more fatigue susceptible), known out-of-plane bending details, cracked details without retrofit, advanced section loss, severe collision damage to steel, or other considerations.

2.4.7 Interval of Fracture Critical Inspections

The interval for this inspection type is generally the same as the interval for Routine Inspections. If an Other Special (Interim) Inspection is warranted (as discussed in IP 2.3.2.4 and shown in Table IP 2.3.2.4-1), the inspection interval for Fracture Critical Inspections is to be coded in BMS2 Item 7A09 Fracture Critical with same interval as 7A09 Other Special (Interim) Inspection and the data box for Item 7A07 Inspection Required shall be checked for Fracture Critical.

The intervals of Table IP 2.3.2.4-1 may be modified if the conditions of the FCMs are not the controlling element in the table. For example, for a bridge with a masonry abutment in Poor condition (1A03 Substructure Condition = 3) but the Fracture Critical 2-girder superstructure (including floorbeams) is in Fair Condition (1A02 = 5), the required frequencies 7A09 could be coded as: NBI 24 months, Fracture Critical 24 months and Other Special (Interim) Inspection 6 months. A limited scope Other Special (Interim) Inspection would inspect the abutments only.

Unless otherwise specified in the F&F Plan, all FCMs are required to have hands-on inspection during each NBI and Other Special (Interim) Inspection.

2.4.8 Element-Level Data Collection for Fracture Critical Inspections

When element-level data is completed for a Fracture Critical Inspection, the inspector must verify that the inventory of elements is complete for the bridge and add any missing elements. Provide Condition State data for BMS2 Items 1A10 and 1A11. This data is to be entered into BMS2 with the other inspection information. Once element-level inspection has been performed and data added to BMS2, “check” the data box for ELEMENT inspection for BMS2 Item 7A06 (Inspection Performed).
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2.4.9 Fatigue

Fatigue is the tendency of a member to fail at a stress level below yield stress when subjected to cyclical loading. Three factors are used to determine probability for fatigue to occur or, conversely, the remaining fatigue life):

- **Stress Range of Cyclic Load**
  The probability of fatigue increases with increased stress ranges.
- **Number of Cycles of that stress range**
  The probability of fatigue increases with increased number of load cycles for a given stress range.
- **Type of Detail**
  Certain details are more susceptible to fatigue than others are.
  AASHTO defines categories of details for their susceptibility to load-induced fatigue.

Fatigue damage can be categorized as due to either load-induced or displacement-induced stresses. Load-induced fatigue damage results from fatigue crack propagation at structural details subjected to the normal in-plane stresses for which they were designed. Displacement-induced fatigue damage is the result of secondary stresses caused by (out-of-plane bending) the interaction between longitudinal and transverse members not quantified in the design of the bridge.

Fracture may occur as a result of fatigue cracking or due to other conditions (see IP 2.4.10).

2.4.9.1 LOAD-INDUCED FATIGUE DAMAGE

The primary cause of load-induced fatigue damage is low fatigue strength (poor) details. Some examples of load-induced fatigue prone details include:

- Groove welded joints, flanges and webs
- Ends of welded cover plates
- Welded attachments and welds in tension zones
- Coped connection plates, especially if the cope is flame cut
- Eyebar links and pin/hanger assemblies

Typically, these details are quantified by AASHTO as Category D or higher (more fatigue susceptible) in Table AD 6.6.1.2.3-1. The greater susceptibility of these types of details to fatigue damage was recognized by AASHTO by assigning them lower allowable stress ranges in design for a given number of stress cycles.

For a fatigue analysis, the live load stress acting on a detail is determined by distributing the load of a single design truck as specified in AD 3.6.1.4 and PD 3.6.1.4. If the fatigue live load stress remains below the allowable stress range (fatigue limit) for a given detail, that detail has infinite fatigue life. However, if the stress range exceeds the fatigue limit, the detail has a finite fatigue life and its remaining fatigue life can be determined (see DM4 PP 5.1.1.1.2).

If a crack or cracks have been detected at a detail, the above procedure for determining remaining fatigue life cannot be used. A more complex fracture mechanics analysis is required. At this point most of the fatigue life has been exhausted and a retrofit is needed.

2.4.9.2 DISPLACEMENT-INDUCED FATIGUE DAMAGE

This type of fatigue damage is usually associated with relatively small out-of-plane movements. These relative movements, measured as small as hundredths of an inch, have been sufficient to cause displacement-induced fatigue damage. The following two conditions are required for this type of damage to occur:

1. A periodic or cyclic out-of-plane force or displacement.
2. An abrupt local change in stiffness where the force/displacement is applied.

Because this damage is caused by cyclic out–of–plane forces in localized areas, cracks can occur in either the primary compression or tension zones of a member. Cracks in a primary tension zone of the member are more critical, especially if their orientation begins to propagate perpendicular to the direction of the primary tension stress and should be retrofitted. A crack in the primary compression-only zone of a member may not propagate any further once the stiffness constraint has been relieved by the crack.

SMALL WEB GAPS: One common problem of displacement-induced fatigue damage occurs at small web gaps where high localized stresses are created because the connection is too rigid to allow the displacement to occur. Some examples of small web gaps include; floorbeam-to-girder connections, stringer-to-floorbeam connections, lateral connections to girder or floorbeam webs, diaphragm connections to girder or stringer webs. For welded connections, small web gaps are defined as gaps that are less than the greater of 4 to 6 times the web plate thickness or two inches (2”). For bolted connections, due to the additional stiffness of connection angles or other connection shapes, the web gap is defined as gaps that are less than the greater of 4 to 6 times the web plate thickness or four inches (4”) (see Figure IP 2.4.9.2-1).

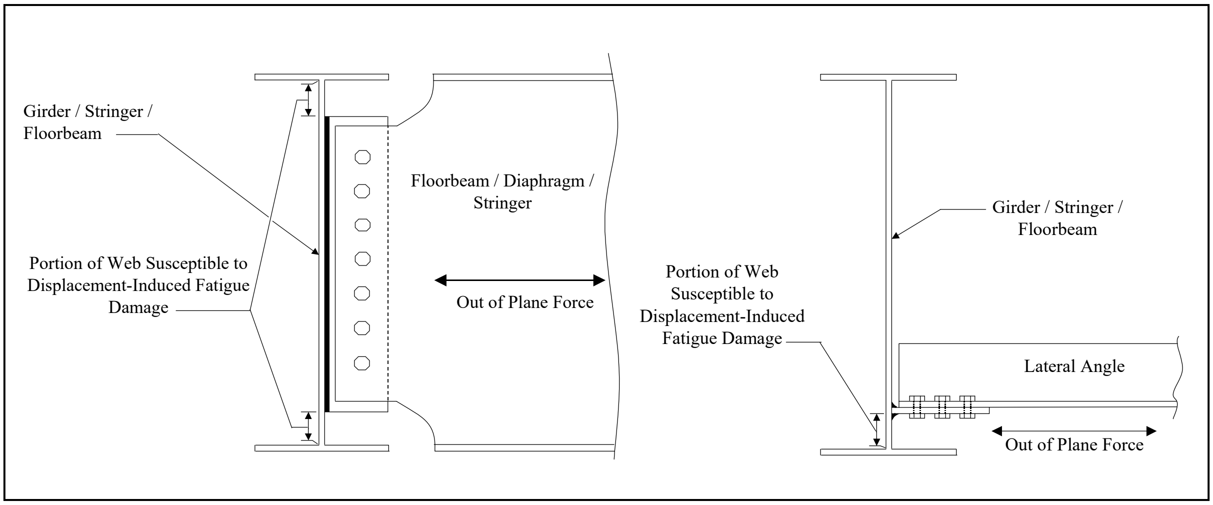

Figure IP 2.4.9.2-1 Details Susceptible to Displacement-Induced Fatigue Damage

2.4.9.3 ANALYSIS OF DETAILS SUSCEPTIBLE TO DISPLACEMENT-INDUCED FATIGUE DAMAGE

It is difficult to analytically assess existing bridges for the remaining life of details with displacement-induced fatigue. The determination of stresses requires detailed refined analysis methods to model the actual conditions. The presumed FEM model for the un-cracked detail will not be valid once cracking has occurred. It may not be feasible to accurately estimate the number of cycles the details have experienced. Accordingly, the use of the analytical approach may be limited to special cases on critical bridges with approval of the Bridge Inspection Section Chief.

2.4.10 Other Details Susceptible to Fatigue and Fracture

Other bridge details common on non-redundant bridges that are susceptible to fatigue and fracture include pin and hanger assemblies and truss gusset plates.

2.4.10.1 GUSSET PLATES FOR TRUSS MEMBERS

Lessons learned from the 2007 collapse of the I-35W truss in Minnesota include the fact that truss gusset plates need to be thoroughly inspected and load rated to fully ascertain the safety of the bridge. Gusset plates may be deficient due to original design, section loss and/or overload.

Perform a hands-on inspection of all truss member gusset plates during each NBI inspection and during Other Special (Interim) Inspections when the gusset plate deterioration warrants. In the F&F Plan, specify the gusset plates to receive hands-on inspection during Other Special (Interim) Inspection.

Measure remaining section of gusset plates and fasteners, noting any plate distortion, and document findings in such a way to fully support their analyses. See IE 4.3.5.6.6 for additional information on gusset plate inspection. Digital photos of gussets with contour lines indicating remaining section thickness is one best practice for inspection and documentation.

Also, include load ratings of gusset plates as separate members in the bridge analysis. See MBE Appendix L6A for additional discussion of gusset plate analysis.

2.4.10.2 PIN AND HANGER ASSEMBLIES FOR NON-REDUNDANT GIRDER BRIDGES

Pin and hanger assemblies (with or without catcher systems) on non-redundant steel girder bridges are critical features for inspection. The pin and hangers are to receive hands-on inspection along with catcher system during every NBI inspection and during Other Special (Interim) Inspections when their deterioration warrants. Specify portions of structure requiring hands-on inspection during Other Special (Interim) Inspection in the F&F Plan. See IE 4.3.5.6.11 for further discussion.

In the F&F Plan, specify the documentation of the positions of pin and hanger assemblies and their catcher system in both longitudinal and transverse directions. Record temperature at time of inspection.

2.4.11 Fracture

Fracture is the sudden and unstable failure of a member in tension. Fracture occurs when a crack reaches a critical size relative to the material toughness, temperature, and loading rate. Fracture is known to have occurred due to member defects and at details with intersecting welds.

2.4.11.1 MEMBER DEFECTS

Member fabrication defects such as notches, gouges, and nicks that occur in tension or reversal zones can lead to fracture because they create areas of unintended stress concentration. These defects may be the result of damage during fabrication, erection, rehabilitation, or due to collisions while in service. Fracture can initiate at or adjacent to these defects particularly if the orientation of these defects is perpendicular to the direction of the tension stress.

Welding also introduces defects into a member. Welds need to be examined for cracks within the weld metal, at the toe of the weld and in the base metal adjacent to the weld toe. Closely examine poor quality welds since fatigue damage is more likely to begin there.

It was common practice to use tack welds on built-up riveted members fabricated from 1945 through 1960. Of particular concern are truss bridges with tack welds used at lacing bars, tie plates, and batten plates on tension members. Tack welds were previously thought to provide a path for the crack to propagate from one of the member's elements to another, however research conducted by Dr. Robert Connor of Purdue University shows this is not the case. Reference NCHRP 20-07 Task 387, Maintenance Actions to Address Fatigue Cracking in Steel Bridge Structures for additional information.

Members that have misplaced holes filled with plug welds on fracture critical members should receive hands-on visual inspections. Past practice was to fill these holes with weld metal (plug weld) rather than leaving them open or installing bolts. Note if the weld metal is not ground smooth or of poor quality otherwise. Of particular concern are tension members on truss bridges.

Bridge inspectors are to carefully examine plug weld locations, looking for breaks in the paint and the formation of oxide powder or rust stains. If weld filled or plug welded holes are encountered in tension areas of fracture critical members, the weld metal should be tested using NDT. A retrofit for this problem would be removal of the weld metal and reaming the hole for the installation of a high strength bolt. The bolt should be tightened to prevent crevice corrosion caused by the accumulation of water or debris.

2.4.11.2 INTERSECTING WELDS

Intersecting welds on some bridge details in tension or reversal zones have led to brittle fracture and failure of main longitudinal bridge members without warning. Intersecting welds are defined as welds that run through each other, overlap, touch, or have a gap between their toes of less than 1/4". The intersecting welds of the web-splice-to-flange or flange-splice-to-web are not of concern here. Three-dimensional details with intersecting welds are the critical intersecting welds. These types of details introduce an out of plane force at the intersecting weld. Examples of some details that may have critical intersecting welds include:

1. Wind bracing connections to girder webs.
2. Floorbeam connections to girder webs.

More often than not, the bridge design and shop drawings will not indicate that intersecting welds are present on a bridge. However, excessive welding during fabrication or repairs has resulted in intersecting welds. Because these welds have caused girder failures on redundant, as well as, fracture critical girders, inspectors should examine steel bridges carefully for their presence.

If intersecting welds are found on a structure, immediately notify the District Bridge Engineer. Bridge closure may need to be considered. Fracture Critical Inspections should be used to inventory and then monitor them.

Every Fracture Critical Inspection must include a "hands-on" inspection of all intersecting weld details in tension or stress reversal zones, including the use of NDT when cracks are noted or suspected. Give priority and emphasis to bridges with Fracture Critical Members (FCMs) with intersecting welds. For instances where holes have been drilled to arrest cracks, inspectors must ensure that the crack is not propagating on the opposite side.

Important points to note about the failure caused by these intersecting welds:

1. The failure mode is brittle fracture which may be sudden and without warning.
2. The failure is not fatigue related and may occur under low stress levels or with very low cumulative truck traffic.
3. The failure is not material dependent and may occur in ductile material with good CVN properties.
4. While the welds may crack, failure of the member in compression zones is unlikely.
5. On a non-redundant FCM, the fracture of the weld may lead to complete structure failure.

Because the failure mode of intersecting welds is sudden and unpredictable nature, repairs and retrofits to cracked and uncracked locations must be given high priority.

The intensity and interval of these inspections are discussed in IP 2.4.6 and IP 2.4.7.

2.5 CULVERT AND STONE MASONRY ARCH STRUCTURE INSPECTIONS

2.5.1 Culvert Inventory and Inspection Requirements

Culvert and drainage structures that meet the definition of a bridge will be considered a bridge culvert. Bridge culverts will be inventoried and inspected as required of any bridge. For a complete discussion of Culvert Inspections, refer to FHWA's Bridge Inspector's Reference Manual.

2.5.2 Multi-Plate Corrugated Metal Culverts

Large-span multi-plate culverts, including box culverts, arches, pipe-arches, and circular pipes are relatively flexible soil interaction structures and more susceptible to failure when they lose their original global cross-sectional geometry. The inspection of these multi-plate culverts is to be sufficiently detailed to detect and monitor deformations (e.g., bulging; non-uniformity of the arch soffit, longitudinally or transversely; misalignment of plates; tearing) that could lead to a partial or complete collapse of the structure. Culverts under shallow earth fill are especially vulnerable to such deformations.

Bridge inspectors will monitor the integrity of the culvert's shape as the primary indicator of any structural distress. The inspection file is to contain sketches indicating the as-built geometry and subsequent measurements to monitor the structure's performance at a minimum of two cross-section locations. Paint marks on the culvert will assist the inspectors in ensuring measurements are taken at consistent locations. See IE 4.3.5.10 for more information on inspection of Corrugated Metal Culverts.

2.5.3 Stone Masonry Arch Bridges

Stone masonry arch structures are some of the oldest bridges in PA. Their construction varied from rough to ashlar (cut or dressed) stonework. Regardless of the construction method, these bridges are particularly vulnerable to:

- Scour of foundations – Any movement allowed by the foundation, either due to scour or to softer materials, can lead to failure of the masonry arch.
- Failure of closed spandrel wall – The gravity-type walls are susceptible to freeze-thaw cycles in the poorly drained roadway fill.

See IE 4.3.5.6.15 for further requirements for the inspection of these bridges.

2.5.4 Interval of Inspection for Stone Masonry Arch Bridges

All stone masonry arch bridges in poor condition shall have an Other Special (Interim) Inspection completed each year per Table IP 2.3.2.4-1 (12 month interval).

For Department-owned stone masonry arch bridges the biennial NBI inspection shall be performed between April 1 and April 30 in order to have these structures evaluated just after the seasonal freeze-thaw cycle. Owners of non-Department bridges are not required to meet the April timeframe for their structures but are encouraged to do so. Several spandrel walls have failed quickly in the early spring, resulting in the loss of roadway material that could have caused vehicles to plunge into the stream. Inspections in early spring may identify impending failures, allowing time to prevent sudden failure.

2.6 INSPECTION OF BRIDGES OVER WATER

2.6.1 PA's General Approach to the Safety of Bridges Over Water

Nationwide and in PA, more bridges are lost each year due to scour than any other reason. Many times, these bridge losses occur during regional or localized flooding and their loss from the transportation system can make recovery from the original weather event even more difficult. To combat this loss of structures from the transportation system and protect our valued infrastructure, PA uses a threefold approach:

- Underwater inspections of bridge substructure units are used to verify the structural condition of the underwater elements, to verify integrity of their foundations and to identify critical anti-scour maintenance needs.
- An assessment of the bridge's vulnerability to scour is made so that critical bridges can be identified for closer monitoring and scour countermeasures.
- During high water events, bridges whose safety is very susceptible to scour are required to be monitored.

PA's three-pronged approach meets the NBIS requirement for the State having procedures for underwater inspection, as per the FHWA's interpretation contained in their Technical Advisory "Evaluating Scour at Bridges" (T 5140.23 October 1991) as well as the memorandum from FHWA revising the coding of SI&A Item 113 dated April 27, 2001.

2.6.2 Underwater Inspections

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

2.6.2.1 PURPOSE OF UNDERWATER INSPECTIONS

Regularly scheduled Routine Inspections include the inspection and evaluation of all pertinent bridge components to ensure that the structure continues to satisfy present safety and service requirements. The purpose of underwater inspections is to provide similar information on underwater portions of a bridge to evaluate their overall safety and, especially, to assess the risk of failure due to scour.

2.6.2.2 DESCRIPTION OF UNDERWATER INSPECTIONS

During periods of low flow, underwater members will be inspected visually and by feel using probing rods, water boxes, sounding lines or other hand tools while wading. Since the majority of inspections of the underwater portions of bridges can be performed using wading and probing methods, they typically fall within the scope of Routine Inspections and the capabilities of both in-house Department inspection staff and inspection consultants. When the physical condition of the substructure members or the integrity of their foundations cannot be determined using the probing tools due to high water, high flow, turbidity, etc., inspection by divers is required. Only underwater inspections performed by divers are defined as "underwater" and coded as such in BMS2. New technology, including ground sensing radar, ultrasonic techniques, remote video recorders, and others have also proven to be alternate methods for underwater inspections of substructure foundations in selected situations.

Key information to be determined in every underwater inspection about the integrity of the foundations is the top of streambed relative to the elevation of the substructure foundations. Because scour can vary significantly from one end of a footing to the other, a single probing reading is not sufficient. Baseline streambed conditions should be established by waterway opening cross sections and by a grid pattern of probing readings around the face of a substructure unit. This baseline information makes future monitoring and assessment easier and more accurate. The current streambed conditions and changes since the last inspection are critical inputs to the bridge scour assessment.

2.6.2.3 INTENSITY OF UNDERWATER INSPECTIONS

Each bridge shall have local benchmarks established near each substructure unit to enable inspectors to quickly and accurately determine the depth of adjacent scour. These benchmarks can be as simple as a painted line or PK survey nail driven into the wall in a place visible during high water. The location of these scour-monitoring benchmarks should be referenced in the inspection records. Use previously established benchmarks when possible to provide a long-term record of scour conditions. If new benchmarks need to be established, provide conversion from new to old datum.

During Underwater Inspections, particular attention should be given to foundations on spread footings where scour or erosion can be much more critical than at deep foundations on piles or caissons. However, be aware that scour and undercutting of a pier or abutment on a deep foundation can also be quite serious. The foundation's vertical support capacity normally will not be greatly affected unless the scour is excessively severe, but the horizontal stability may be jeopardized. This condition becomes particularly unstable when erosion has occurred on only one face of the substructure unit, leaving solid material on the opposite face. Horizontal loads may also have been produced by earth, debris, or rock fills piled against or adjacent to substructure units whose loads were obviously not provided for in the original design. Such unbalanced loading can produce an unstable condition, requiring corrective action.

*i*FORMS, BMS2 AND UNDERWATER INSPECTIONS: *i*Forms D-450 Form G allows inspectors to record each underwater component. The BMS2 6B, 7A, IU, and IN inspection screens also have data fields to indicate the underwater inspection requirements, including information to assess the scour criticality, required underwater inspection interval, level of inspection, and foundation data to manage and schedule the underwater inspections.

UNDERWATER INSPECTION AGREEMENTS: Because of the challenge of maintaining trained inspector divers and adequate equipment for a small number of underwater diving inspections, BIS maintains statewide open-end engineering consultant agreements to provide underwater inspection services to the Districts. Under these agreements, consultants perform scheduled and emergency underwater inspections of State and Local bridges and to provide additional expert services in this area as needed. Where possible and practical, these statewide open-end agreements are to be used by the Districts and Local bridge owners for diving inspections, instead of contracting separately for these services. Probing and other underwater inspection methods are also available through these agreements. See IP 1.10 for further guidelines on the use of these agreements. See Appendix IP 01-H for the standard scope of work used for underwater inspections.

2.6.2.4 MAXIMUM INTERVALS FOR UNDERWATER INSPECTIONS

Underwater inspections are intended to investigate two critical issues regarding the condition of bridge substructures located in water:

- The condition of structural components (including pier shaft, abutment walls, footings, etc.) under water.
- The integrity of the substructure foundation (including underlying soil, piles, caissons, etc.) against scour at each substructure unit in water.

The inspection of the foundation of a substructure unit and the determination of its ongoing resistance to scour is critical for the overall safety of the bridge. Because the integrity of the foundation against scour can suddenly and dramatically change in a relatively short time (as compared to physical condition of the structure components), shorter intervals for inspection of the foundation are warranted. The recommended intervals for underwater inspection of the foundation of substructure units for bridges over water are based upon a scour assessment of each unit and are shown in Table IP 2.6.2.4-1.

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Table IP 2.6.2.4-1 – Underwater Inspection Intervals for Substructure Foundations

Scour Critical Bridge Indicator Rating (SCBI) for Substructure Unit	UW Inspection Interval for Foundation	Comments
N	Not needed	
9	Not needed	Substructure unit foundation (including piles, caissons, etc.) is well above flood water elevation for 500-year frequency flood or is not subject to stream/tidal flow.
8	60 Months	Substructure unit foundation has been determined to be STABLE by: ▪ Calculated scour conditions - *Calculated scour is above the top of footing.* (*This includes new bridges with properly designed measures),* or ▪ A culvert with an integral bottom and no scour problems, or ▪ The Scour Critical Bridge Indicator (SCBI) from PA Observed Scour Assessment for Bridges (OSAB) would rate the substructure unit = 8.
7	60 Months	Countermeasures have been installed *and remain in place* to correct a previous problem with scour at this substructure unit. Countermeasures have been verified through scour assessment. Unit is no longer considered to be scour critical by calculated scour method or PA OSAB (SCBI = 7); however, it still requires a Scour POA.
6	SCBI Code Correction Needed	Integrity of substructure unit foundation against scour has not been determined. Neither scour calculations nor the SCBI rating from PA OSAB for this substructure unit foundation has been made.
5	60 Months	Substructure unit foundation was determined to be STABLE by: ▪ Calculated scour is at or above bottom of footings, or ▪ For deep foundations, calculated scour is between footing and pile/caisson tip and analysis of substructure unit using calculated scour depth indicates foundation is stable, or ▪ PA OSAB would score substructure unit SCBI = 5
4	24 Months or After High Water Event*	Substructure unit foundation was determined to be STABLE by: ▪ Calculated scour conditions and analysis results are same as SCBI = 5 except that field conditions indicate action may be needed to protect exposed foundation from additional scour and erosion. ▪ PA OSAB would score substructure unit SCBI = 4 and requires a Scour POA.
3	24 Months or After High Water Event*	Substructure unit foundation is SCOUR CRITICAL because its foundation determined to be UNSTABLE by: ▪ Analysis of substructure unit foundation considering scour indicates instability. Scour may be within limits of spread footings or of pile tips and be unstable. Scour below spread footing or deep foundation tips cannot be deemed stable. Or ▪ PA OSAB would score substructure unit SCBI = 3 and requires a Scour POA. *NOTE: Action is recommended to protect the substructure unit foundation from further scour.*
2	6 Months or After High Water Event*	Substructure unit foundation is SCOUR CRITICAL. Field conditions indicate that extensive scour has occurred at the substructure unit and it is considered UNSTABLE. Bridge requires a Scour POA. *NOTE: Immediate action is required to protect the substructure unit foundation from further scour. Additionally, if the structure warrants an SCBI rating factor of "2"or less, Item 1A02 – Substructure condition rating should also be assigned the same rating value (Ref: FHWA Memo dated April 27, 2001).*
0, 1	24 Months or After High Water Event*	Substructure unit foundation is SCOUR CRITICAL. Bridge is closed to vehicular traffic. Bridge requires a Scour POA. *NOTE: Additional underwater inspections may be needed to monitor stability, so actions may be taken to prevent uncontrolled collapse (especially if bridge remains open to pedestrians). Additionally, if the structure warrants an SCBI rating factor of "2"or less, Item 1A02 – Substructure condition rating should also be assigned the same rating value (Ref: FHWA Memo dated April 27, 2001).*

*Refer to the Scour Plan of Action (POA) for scour critical bridges for instructions on the need for inspection after a high-water event.

The Scour Critical Bridge Indicator (SCBI) ratings for BMS2 Item 4A08 are to be applied to each substructure unit to determine its recommended interval for underwater inspection as shown in Table IP 2.6.2.4-1. The inspection interval for underwater inspections is to be coded in BMS2 Item 7A09 and item 7A07 shall be checked.

The condition of the structural components shall be verified along with the investigation of the foundation material. The interval of underwater inspection of a substructure unit is not to exceed 5 years.

2.6.3 Assessment for Bridge Scour

2.6.3.1 GENERAL REQUIREMENTS FOR SCOUR ASSESSMENTS

INTRODUCTION: One of the more effective ways of preventing the loss of a bridge due to scour failure is to identify those bridges most likely to be vulnerable to failure due to scour. With this determination, called a scour assessment, the bridge inspectors and owners can concentrate inspection/monitoring efforts and remedial actions to mitigate conditions at bridges with critical vulnerability. To this end, scour assessments become an important part of bridge safety inspections in PA. Moreover, such assessments are required by the NBIS because they are deemed to be a key part of a comprehensive bridge inspection program.

Since 1982, PennDOT bridge design policy has required that all bridges built using federal funds are required to be designed against failure due to scour based on theoretical scour calculations from a Hydrologic and Hydraulic (H&H) analysis. In order to address all other bridges, and as approved by FHWA, PennDOT contracted with the United States Geological Survey (USGS) in the late 1990’s to develop an algorithm, known as the SCBI Scour Calculator, and to perform the initial site assessments for all NBIS-length state and local bridges in order to provide the necessary data for the initial determination of the SCBI code for these bridges. Once these initial codes were reviewed and approved by PennDOT, these SCBI codes, and other specific data collected by USGS, were entered into the Bridge Management System database. The USGS also developed a web-based database that allowed the PennDOT Districts to perform new runs of the Scour Calculator as warranted by changes in site conditions at the bridges. This USGS database is no longer available, but the SCBI Scour Calculator was incorporated into the BMS2 database and PennDOT’s iForms bridge inspection software such that it is available for use by PennDOT and consultant bridge inspectors.

PURPOSE OF SCOUR ASSESSMENTS: The main purpose of the scour assessment of an existing bridge is to determine whether the bridge is vulnerable to failure due to scour. A scour critical bridge is one whose foundation(s) has been determined to be unstable for the predicted scour conditions. The BMS2 Item 4A08 - Scour Critical Bridge Indicator (also NBI Item 113) is used to record a single digit coding indicating the bridge’s vulnerability to failure due to scour. See BMS2 Coding Manual, Publication 100A for Item 4A08 coding instructions.

DESCRIPTION: The results of the scour assessment are to be used in conjunction with information from Routine, Other Special (Interim) or Underwater bridge inspections to ensure that current stream (and bridge) conditions are used to evaluate and update the current scour vulnerability status of the bridge. Scour is a dynamic process, and changes in stream and streambed conditions (e.g., scour depth/location, aggradation, degradation, debris, installation of countermeasures) discovered during inspection can dramatically affect the vulnerability of a substructure unit foundation and must be considered. Accordingly, the inspection information and the scour assessment must be used together for the evaluation of the overall safety of the bridge. The inspection information is needed to validate and support the input parameters and results of the scour assessment. The scour assessment results are used to determine if scour poses a threat to the bridge. These scour assessments must be reviewed and updated when an inspection shows that scour conditions at the bridge have changed. Therefore, it is important that all relevant documentation be included in the bridge inspection file. For PennDOT standards on measuring and documenting scour, refer to Appendix IP 02-E.

The two acceptable methods of performing scour assessments in PA are:

1. Theoretical Scour Calculations – “Computed” Scour Assessment. The bridge (or measures/countermeasure) has been designed to resist failure due to scour as determined by a formal H&H Analysis (see IP 2.6.3.2). Bridges with a “Computed” Scour Assessment must also have all IN and IU fields completed on the Underwater screen of BMS2. If the observed field conditions no longer

match the as-designed conditions used in the H&H Analysis, the coding for BMS2 Field IU03 should be revised from a "Computed" Scour Assessment to an "Observed" Scour Assessment. Measures are designed before a scour issue has occurred and countermeasures are placed to correct a scour issue that has occurred.

2. PA's Observed Scour Assessment for Bridges methodology – Observed Scour Assessment. The bridge has not been designed to resist failure due to scour. Therefore, the bridge must be assessed for scour vulnerability using data collected from plans and field observations and by running the SCBI Scour Calculator (see IP 2.6.3.3).

NBIS BRIDGE & STATE-OWNED 8'-20' STRUCTURE REQUIREMENTS: For all NBIS bridges over water and whose foundations are below the water surface elevation of the 500-year flood:

1. A Scour Assessment (Computed or Observed) for current conditions must be in the inspection file.
2. BMS2 Item 4A08 Scour Critical Bridge Indicator must be determined/verified for accuracy at each Regular and Underwater Inspection.
3. The scour "calculate" button should be clicked during each inspection for bridges over waterways to ensure any changes are reflected in individual SCBI code (IU27), overall SCBI code (IU04) and Item 4A08.

REQUIREMENTS FOR LOCALLY OWNED AND OTHER STATE AGENCY 8'-20' BRIDGES: Scour assessments are not required for non-state owned, non-NBIS bridges. However, the bridge owners are urged to apply them for any bridges at risk due to scour.

2.6.3.2 SCOUR ASSESSMENT USING THEORETICAL SCOUR CALCULATIONS

A scour assessment of a bridge using the theoretical scour calculations is a method based on H&H analyses of the stream and bridge opening. Use DM4 PP Chapter 7 and FHWA Technical Advisory "Evaluating Scour at Bridges" (T 5140.23 October 1991) for guidance on the methodology. In good design practice, the bottom elevations of foundations are established considering the calculated scour depth. These design scour computations are to be used as the basis for the scour assessment and determination of the appropriate SCBI code and should remain in the bridge inspection file.

If existing scour at the bridge is deeper than the calculated scour, the theoretical scour analysis is not correctly modeling the real conditions and the scour assessment should be reanalyzed or assessed using the SCBI Scour Calculator. Any significant change in site conditions should also warrant revisiting the scour calculations or be evaluated using the SCBI Scour Calculator. The scour calculator should be run on every Routine, Underwater or any other inspections where the IN fields are updated and the waterway is evaluated.

For H&H analyses performed on bridges not previously designed to resist scour failure, the following guidance is provided for checking the resultant calculated depth of the theoretical scour to the substructure unit foundation:

1. For spread footing foundations:
   - If the calculated scour is above the bottom of footings - Not scour critical (Item 4A08 codes 8, 7, 5, or 4). Note: Footing may be partially exposed for Item 4A08 codes of "4" and "5".
   - If the calculated scour is below the bottom of footings founded on soil or erodible rock – Scour critical (Item 4A08 code ≤ 3).
2. For deep foundations (piles or caissons):
   - If the calculated scour is above the top of footings - Not scour critical (Item 4A08 code 8)
   - If the calculated scour is below the bottom of footing and above the bottom of pile/caisson – a structural analysis of the foundation unit is needed to determine its stability. If stable, the bridge is not Scour Critical (Item 4A08 code 4 or 5). If not stable, the bridge is Scour Critical (Item 4A08 code ≤ 3).
   - If the calculated scour is below the bottom of pile/caisson – Unstable and Scour Critical

2.6.3.3 SCOUR ASSESSMENT USING PA OBSERVED SCOUR ASSESSMENT FOR BRIDGES

The Department developed an alternative method of scour assessment based upon the observance of geomorphic, hydrologic, and hydraulic features at the bridge site. This multi-disciplinary assessment, which has been approved by the FHWA, is seen as a cost–effective approach to meeting the NBIS requirements for evaluating existing bridges without theoretical scour computations. The Department developed this observed assessment method under an agreement with the United States Geological Survey (USGS).

Under the same agreement, the USGS performed the initial observed scour assessment of some 13,600 Department and local bridges over water. These initial observed scour assessment reports were reviewed for acceptance by the Department's District Bridge Units. All data for these initial observed scour assessments were captured for the Department in a Microsoft Access® database by USGS. The initial reports were distributed to the Districts in electronic format.

The methodology for PA Observed Scour Assessment for Bridges (PA OSAB) is outlined in the USGS Open-File Report 00-64 titled Procedures for Scour Assessment at Bridges in Pennsylvania. This report is available on the BMS2 login screen at: http://www.dot.state.pa.us/public/Bureaus/design/bqad/Pubs/Procedures-for-Bridge-Scour-Assessments.pdf.

The PA OSAB uses an algorithm in a Department software program named SCBI Calculator to determine the value for BMS2 Item 4A08 Scour Critical Bridge Indicator. The SCBI Calculator Manual, which is located on the BMS2 login screen at http://www.dot.state.pa.us/public/BUREAUS/design/Scour-Calculator-Manual.pdf, provides guidance on the use of the SCBI Calculator. If the Item 4A08 - SCBI value from the PA OSAB is based on conditions valid at the time of inspection, it should be used in the inspection as the value for BMS2. The SCBI Calculator can be accessed by the inspectors through BMS2 and *i*Forms. Inspectors should recalculate the SCBI value by selecting the "Calculate" button in the Form G of *i*Forms or the Underwater Inspection Screen for BMS2 after updating the appropriate IU and IN fields as part of the inspection. Item 4A08 shall not have a value of 6 as this code indicates incorrect or incomplete data entry for the IN and IU data items used by the Scour Calculator (e.g. incompatible subunit type and foundation type, subunit type not coded, subunit foundation type not coded, etc.). Detailed information regarding Item 4A08 codes of 6 are provided in the Scour Calculator Manual and the Procedures for Scour Assessment at Bridges in Pennsylvania document. If the SCBI has a value of 2 or less, an FHWA memo dated April 27, 2001 requires the substructure condition rating be set equal to the SCBI coding. Furthermore, bridges with an SCBI of a 2 or less are deemed to be in critical condition.

PA OSAB data is to be reviewed for changes in site conditions during inspections. Because this method is based on field observations of features, maintenance of the pertinent data through Routine, Other Special (Interim), Underwater, and Post-Flood Damage Inspections is vital to the accuracy of its evaluation of the bridge's safety. The Scour Calculator can be used to compute correct values for the SCBI for new conditions. All changes are to be documented in the inspection report.

Table 1 in the SCBI Calculator Manual identifies the data components needed to run the calculator. BMS2 items on the IN Inspection – Underwater Sub Units screen marked with an "(SC)" in Publication 100A are required for each substructure unit in order to recalculate Item 4A08. They are as follows:

Item IN04 – Change Since Last Inspection
Item IN05 – Scour Hole
Item IN12 – OSA Pier/Abutment Foundation Type
Item IN13 – PA Foundation Type
Item IN14 – OSA Foundation Type
Item IN15 – Streambed Material
Item IN19 – Movement Indicator.

These field items should be verified during each Routine, scour related Other Special (Interim) or Underwater inspection to determine the validity of the current SCBI code. The SCBI calculator should be run during each inspection to ensure the changes to the scour critical inputs are reflected in the BMS2 Item 4A08 code.

It is important to note that bridges which are designed with appropriate measures for scour conditions or if no measures are required as determined through an approved H&H Report still require an observed scour assessment, however, the SCBI will be based on the computed value (i.e., BMS2 Field IU03 = C) until field conditions indicate there is clear evidence that the above situations are not applicable (e.g., scour measures/countermeasure deterioration and/or failure).

2.6.3.4 EVALUATION OF SCOUR MEASURES AND COUNTERMEASURES

The Department coding instructions for BMS2 Item 4A08 SCBI indicate that scour measures and countermeasures are to be properly designed or verified through analysis before they can be considered as effective countermeasures against scour. Designed measures and countermeasures can include streambed paving, gabion blankets, grout bags and rip-rap. It is important to understand the difference between a scour measure and a countermeasure. A scour measure is a device designed to resist scour. This is usually installed during new construction or during a rehabilitation project as part of an H&H analysis. A countermeasure is a device installed to correct a previous scour issue at the bridge. The difference is important because bridges with countermeasures require a Scour POA to ensure they resisted scour during an event (Category D). On the other hand, bridges with scour measures do not require a Scour POA.

The other common misconception is a bridge with an Item 4A08 value of 7 is better than a value of 5. The coding of a 7 is for bridges where countermeasures have been installed to mitigate an existing problem with scour and to reduce the risk of bridge failure during a flood event. Instructions contained in a POA have been implemented to reduce the risk to users from a bridge failure during or immediately after a flood event. The coding of a 5 is for a bridge foundation determined to be stable for assessed or calculated scour conditions. Scour is determined to be within limits of footings or piles by assessment (i.e., bridge foundations are on rock formations that have been determined to resist scour within the service life of the bridge), by calculations or by installation of properly designed measures.

2.6.4 Scour Plans of Action

In accordance with the Title 23 of the CFR, Section §650.313(e)(3), a Scour Plan of Action (Scour POA) must be prepared for each NBI Scour Critical bridge. Similarly, Scour Critical State-owned 8’-20’ structures must also have a Scour POA. Scour POA’s document and describe the approaches used to monitor known and potential deficiencies and to address critical findings for bridges identified to be Scour Critical. Scour Critical bridges are to be placed into one of three categories based on the descriptions below. While bridges below in Category D are not Scour Critical, they still require a Scour POA because either action is required to protect exposed foundations (SCBI = 4) or protection has been placed and needs to be monitored (SCBI = 7).

- Category A bridges include all bridges with a BMS2 Item 4A08 SCBI code of 2 or BMS2 Item IN03 Observed Scour rating of 3 or less. Bridge is considered Scour Critical.
- Category B bridges include all bridges with a BMS2 Item 4A08 SCBI code of 3 **and** a BMS2 Item IN03 Observed Scour rating of 4. Bridge is considered Scour Critical.
- Category C bridges include all bridges with a BMS2 Item 4A08 SCBI code of 3 **and** a BMS2 Item IN03 Observed Scour rating of 5 through 9. Bridge is considered Scour Critical.
- Category D bridges include all bridges with a BMS2 Item 4A08 SCBI code of 4 or 7. These bridges are not considered to be Scour Critical but do require a Scour POA. Bridges in this category will need to be inspected after significant flooding events.

The Scour POA’s for Scour Category A, B, C and D bridges include a monitoring program and post-flood inspection plan based on the above categories.

A sample Scour POA form is available in Appendix IP 02-A. These Scour POA’s can be generated from a standard Crystal Report titled “Scour Plan of Action” that is available on Crystal Enterprise. Most information is pre-populated on these forms from BMS2. Other attachments (i.e., plan view scour sketch, cross sections, photos, etc.) may be added and a hardcopy is to be filed in the Bridge Inspection file. It is also required that an electronic file be stored in BMS2 under the Documents link.

FHWA requires that Scour Plans of Action be developed for each Scour Critical NBI bridge by local bridge owners and other bridge owners as well. However, PennDOT also requires a Scour POA for Scour Category D bridges. The procedures detailed here should be used or modified to better meet the owner’s needs as approved by the Department. The local owners’ procedures shall be approved by, and a copy kept on file, by the District in BMS2.

2.6.4.1 SCOUR CRITICAL BRIDGE MONITORING RESOURCES

Information is available to the Districts to prepare for and respond to flooding events. The following resources are available for use to comply with the monitoring requirements of Publication 23, Section 9.11:

- **Scour Critical Bridge Lists:** The Districts and Counties will maintain lists of Scour Critical bridges that are to be monitored during significant flood events. These lists can be generated from a standard Crystal Report titled "Scour Critical Bridge Category List" that is available on Crystal Enterprise and will be updated on a monthly basis. Districts and counties must use Bridge Watch alerts and these lists as the primary source to determine which bridges are to be monitored.

- **Scour Critical Bridge Maps:** GIS maps showing the locations of all Scour Critical bridges in categories A, B and C as well as non-Scour Critical bridges in Category D will be updated by Central Office and provided to District bridge units on a monthly basis. Districts and counties can use these maps to locate the bridges to be monitored. See Publication 23, Section 9.11, for the directory of map locations.

- **Field Manual:** A field manual titled "Scour Critical Bridge Monitoring Field Manual" is available in Appendix IP 02-A. Bridge monitoring personnel are to be familiar with the contents of this manual in order to have the basic knowledge necessary to perform bridge flood monitoring effectively.

- **Weather Forecasts:** Bridge Watch notifications, National Weather Service forecasts and Accuweather alerts provided to the County Maintenance offices or Engineering Districts contain essential information to assist with preparations for the start of flood monitoring of bridges. In some months, Accuweather alerts are issued when 2 inches or more of rain is forecasted and/or when Flood Warnings are issued by the National Weather Service. Department personnel should anticipate the need for monitoring when these alerts are received. Due to shorter duration, higher intensity (popup) storms, monitoring may be required for some bridges with less than 2 inches of rainfall.

2.6.4.2 MONITORING

Monitoring Scour Critical Bridges shall be in accordance with Publication 23, Section 9.11.

Bridges are to be monitored in order of precedence with Category A bridges having the highest priority. Category A bridges on the Interstate must be monitored without exception (BPN = 1). Using the information presented on the Scour Critical Bridge Lists and the Scour POA's, an order of precedence can be further defined using information such as:

- Scour Critical bridge Categories A through C
- Business Plan Network (BPN), BMS2 Item 6A19
- Traffic Volumes, BMS2 Item 5C10
- Overtopping frequency of bridge and/or roadway approach, BMS2 Item 1A06
- Bridge configuration (length, # spans, support types, redundancy, etc.)

The recommended minimum interval for monitoring Category A bridges is once every four (4) hours from the onset of monitoring. The recommended minimum frequencies for monitoring other bridges are once every 12 hours for Category B bridges and once every 24 hours for Category C bridges. Note that each scour critical bridge being monitored requires a minimum of two (2) visits. Discontinue monitoring per Publication 23, Section 9.11.

Notes: 1) High water events and flash flooding can be localized. Conversely, flood events can be widespread and may not occur for a day or two after rain has begun. In either case, flood monitoring of bridges is to be performed when Bridge Closure/Outage occurs (see Publication 23, Section 9.11).
2) Except for Category A bridges on the Interstate, the above monitoring procedures may be waived when a Declaration of Emergency has been authorized.
3) Category A bridges must be closed at such time as the water level reaches the low chord of the bridge (i.e. pressure flow condition). If it is deemed necessary to keep a bridge open, (e.g., for emergency vehicle passage or emergency evacuations), then the bridge must be continuously monitored (i.e. placed under a 24/7 watch) until flood waters subside and a post-flood damage inspection has been completed.

2.6.4.3 INSPECTION

Post-Flood Damage Inspections are required for Scour Critical Bridges Categories A through C, and Category D bridges in areas or watersheds where significant flooding events have been reported by the counties or bridge closures have occurred. Depending on the size of the area affected by flooding, numerous flood damage inspections may need to be completed in a short time frame. Statewide bridge inspection open-end contracts may be a source for accomplishing these inspections.

Once flood waters have subsided, Scour Category A, B, C and D bridges are to be inspected for flood damage as follows:

- Category A: Inspect all bridges for flood damage where a significant flooding event was experienced. Bridges in this category that have been closed due to approach roadway or bridge overtopping or pressure flow must be inspected for flood damage before reopening to traffic.
- Category B and C: Inspect all bridges for flood damage where a significant flooding event was experienced or if the bridge has been closed due to either approach roadway or bridge overtopping or pressure flow must be inspected for flood damage before reopening to traffic.
- Category D: Inspect for flood damage after each significant flooding event or if the bridge has been closed due to overtopping or pressure flow.
- Refer to the Scour POA's for additional guidance.

Any additional bridge not defined in the bullet points above that was subjected to overtopping or pressure flow shall be subjected to a post-flood inspection. This inspection should be completed within 7 days of the bridge being reopened to traffic.

All Category A bridges which have been closed as a precautionary measure are to be inspected first so that bridges can be re-opened as quickly as possible. It is recommended that the inspection of the remaining bridges be prioritized in order of Category (Category A, B, C, D) since these represent the level of vulnerability to scour.

Scour Critical Bridges that have been closed due to the flood event require District Bridge Engineer approval prior to re-opening.

2.6.4.4 REPORTING

Bridge flood monitoring personnel are to complete a Bridge Flood Monitoring Log (paper or in Bridge Watch) for each Category A, B or C bridge monitored. Entries are to be made on the log each time the bridge is visited. See Appendix IP 02-A for a sample log sheet.

Bridge closures are to be reported by the counties using the Road Condition Reporting System (RCRS) and in the Bridge Watch system. RCRS reports all active bridge and roadway closures. Bridges that have been closed as a precaution, such as those that have gone into pressure flow or have overtopped, are to be reported to RCRS with a "Cause" description of "Bridge Precaution." Those bridges closed due to scour failure are to be reported in RCRS with a "Cause" description of "Bridge Outage." Those bridges closed due to flooding or possible washout failure are to be reported in RCRS with a "Cause" description of "Bridge Flood Washout/Damage." Bridge Watch reports scour critical bridge issues. For bridges closed in Bridge Watch, the user should select the appropriate closure option.

- During flood events:
  - Per Publication 23, Section 9.11, Highway Maintenance Managers are to report to the District Bridge Engineer by phone or email on a daily basis. Counties may now use Bridge Watch to update the District Bridge Engineer.
  - District Bridge Engineers are to report all counties where active flood monitoring is occurring to the Bridge Inspection Section Chief on a daily basis. If bridges are reported in Bridge Watch in real time, then this satisfies this requirement.
- After flood events:
  - Highway Maintenance Managers will assemble and submit monitoring logs per Publication 23, Section 9.11. These logs may be scanned and submitted electronically. Highway Maintenance

Managers may upload these logs to Bridge Watch, or monitor bridges directly in Bridge Watch from a desktop or using the mobile app in lieu of monitoring logs and weekly submittals. Highway Maintenance Managers will have the authority to add local partners as users in Bridge Watch.

- Using Bridge Watch, the information reported by the County Managers, information reported in RCRS for bridge closures, and rainfall accumulation data, the District Bridge Unit will screen and prioritize the bridges to receive post-flood inspections by bridge inspectors. Scour Critical bridge lists, monitoring data from the counties and Scour POA forms are to be referenced for this effort.
- District Bridge Engineers are to submit weekly status reports to the BIS identifying the bridges monitored and the summary results for bridges inspected following flood events using the High Water Inspection Weekly Report Form provided in Appendix IP 02-A. Districts may use Bridge Watch for all reporting in real time in lieu of status reports.

2.7 INSPECTION OF CLOSED BRIDGES

2.7.1 Purpose of Closed Bridge Inspections

When a public road bridge is closed to vehicular traffic but not removed from the site, continued inspection is required on a regular basis to assure adequate safety to the public having access on or beneath the structure. Accordingly, assure that necessary barricades for vehicles and/or pedestrians are in place. The physical integrity of the structure must be regularly assessed to ensure that a partial or total structural failure will not occur and endanger the public, even with no one on the bridge.

If it is an NBIS bridge and the crossing remains on the inventory of public roads, it must be inspected in accordance with NBIS and Department standards. Closed bridges less than eight feet (8’) in length owned by the Department or carrying State Routes must be inspected in conformance with those same standards. Although a bridge may be closed, the inspection must be current. Federal-aid funding eligibility is maintained if rehabilitation or replacement is identified on the 12 Year Program.

2.7.2 Description of Closed Bridge Inspections

A safety inspection of a bridge closed due to structural conditions is similar to a Routine Inspection in the kinds of inspection data that must be collected. In general, rate each inspection item without being influenced by the fact the bridge is closed. For example, the ratings for BMS2 Item 4A10 Deck Geometry Appraisal Items would not increase because the ADT had decreased (to zero). Maintenance needs should list all needed activities as if the bridge were still in service.

The closure barricades must be checked for integrity and effectiveness to maintain public safety. Permanent, fixed type barricades of concrete median barrier, steel guide rail, or other fixed type barrier should be installed in a manner that positively prohibits vehicles from the bridge. If the bridge is to be closed to pedestrians, a steel chain link fence, or other suitable barrier that prohibits pedestrian access should also be installed. If pedestrians are permitted to use the bridge, the bridge’s structural safety for AASHTO’s pedestrian loading must be verified at each Closed Bridge Inspection. Appropriate signing must also be in place, both at and in advance of the closed bridge.

BRIDGES CLOSED FOR CONSTRUCTION:

- When a public road bridge has been closed completely for replacement, it is no longer necessary to keep the inspection record current. For Department bridge projects, a bridge being replaced essentially becomes the property of the contractor when the project starts. However, if public pedestrian traffic is to be maintained on a bridge otherwise closed to vehicles, the responsibilities for the safety of the bridge and the need for inspection should be specified in the construction contract.
- If an NBIS bridge is partially closed to vehicular traffic for a staged construction project (either rehabilitation or replacement), it is still part of the public road and the open portion is to be inspected as a Routine Inspection on the regular cycle.
- If an NBIS bridge has been completely closed for rehabilitation, re-inspection during construction is not required. However, upon the essential completion of work and prior to the bridge going back into service, a Routine Inspection (or Initial Inspection for extensive restorations) is to be performed. The

inventory and inspection data describing the bridge's rehabilitated condition must be entered into BMS2 within 90 days of the bridge going back into service.

2.7.3 Intensity of Closed Bridge Inspections

The level of effort required to perform a Closed Bridge Inspection will vary, as do other inspections, according to the structure's type, size, design complexity, existing conditions, and location, but is generally much less than Routine Inspections of in-service bridges. The criticality of the conditions that necessitated the closing and the risk of collapse must be considered when determining the scope of inspection. The level of scrutiny that the portions of the bridge not critical to public safety receive may be reduced from the intensity of a Routine Inspection, at the discretion of the District Bridge Engineer.

The focus of the Closed Bridge Inspection is to determine if the bridge is safe to remain in place in its current condition. If pedestrian traffic is allowed, the safety of the bridge to carry this loading is to be determined. Structural analyses of closed bridges with significant changes in structure conditions since the initial closure may be warranted.

2.7.4 Interval of Closed Bridge Inspections

The maximum interval of inspection of closed bridges is 24 months. More frequent inspections may be warranted for bridges in critical condition.

2.8 RAILROAD BRIDGE INSPECTIONS

The inspection of bridges that carry or cross railroads requires attention to safety and compliance with special rules of the railroad. For their own protection, inspectors from the Department and the bridge owner personnel are to be instructed to exercise extreme caution when working near the railroad tracks, electrified lines, high speed trains and other railroad related hazards and operations. Typically railroad owners require that all inspectors working on their property or in danger of fouling their track(s) receive an annual training certification. It is the responsibility of the inspector to research the requirements of the specific railroad and be in compliance with those requirements.

2.8.1 Railroad Notification

Where a highway bridge involves a railroad crossing that has been abolished by PUC Order, notification to the railroad is not required.

If portions of a highway bridge over a railroad need to be inspected within the railroad's right-of-way, notify the railroad prior to performing the inspection. Railroad right-of-way varies for each railroad. As a precaution, or when in doubt, regarding railroad right-of-way, notify the railroad.

When it is known that a highway bridge inspection will take place within the railroad right-of-way, follow the guidelines contained below. Where inspection personnel would be exposed to potentially dangerous conditions due to equipment or railroad (e.g., electrified lines, high speed trains or similar conditions), the railroad must be notified in advance and the inspection is not to proceed until arrangements have been made with the railroad. Normally, the railroad will issue a right-of-entry permit with terms and conditions that must be followed during entry.

The railroad must be notified, at least twenty (20) calendar days in advance, of the intent to enter onto their right-of-way to conduct an inspection whenever any one of the following conditions is present:

1. Equipment (such as a bridge inspection crane) or other aids (such as scaffolding) is required in the span over the railroad.
2. The bridge is located over a railroad that is electrified.
3. There is any possibility of physical interference with railroad operations.
4. There is a dangerous condition for the bridge inspection crew due to high-speed railroad operations, close horizontal clearances or other similar conditions.
5. Inspection involves work within or above the zone measured 12 feet horizontally from the center of track rails.

Notification to the railroad must include a detailed description of: work to be performed, the number of people in the inspection party, description of any equipment that will be used (bridge inspection crane, scaffolding, etc.), anticipated length of time of inspection, and other pertinent information.

2.8.2 Insurance Requirements When Working Within the Railroad Right-of-Way

Depending upon the scope of work involved and the type of railroad operations involved, the affected railroad, when contacted, may require Railroad Protective Liability Insurance coverage and/or watchman and flagman protection.

Requirements for Railroad Protective Liability Insurance will be established by the operating railroad and must be furnished prior to conducting the inspection by the Department and/or its consultant. The Department cannot provide this insurance. The railroad can purchase the insurance and be reimbursed for the premium either directly by the Department or through its consultant.

2.8.3 Railroad Flagmen or Watchmen Requirements

Requirements established by the affected operating railroad for watchmen and flagmen during the inspection will be determined prior to the performance of the inspection and strictly adhered to by the inspectors.

2.8.4 Cost of Special Items for Inspection of Highway Bridges over Railroads

When the Department's consultant performs the inspection, insurance (for railroads) and all watchmen and flagmen and other railroad service fees should be paid directly to the railroad by the consultant. The consultant's agreement with the Department must have provisions to pay costs of services by others for such railroad costs. At the option of the District, a separate agreement may be entered into between the Commonwealth and the railroad, to reimburse the railroad directly for the costs of insurance, watchmen, flagmen and other railroad services.

When consultants perform the inspections, they can purchase the insurance on their own or utilize the insurance coverage offered by some of the railroads under the Strike-Off Letters. The consultant shall pay such costs and bill the Department under the terms of their agreements with the Department. Because the Department is self-insured, Norfolk Southern does not require the Department to purchase railroad insurance when the Department’s own forces perform the inspection.

For non-Department bridges, similar procedures are to be used.

For NBIS bridges, the cost of these special items for railroad bridge inspection is eligible for 80% Federal funding.

2.9 BRIDGE AND STRUCTURE EMERGENCIES

2.9.1 Reporting Bridge and Structure Emergencies

Whenever a serious bridge or structure problem or emergency occurs on a Department or Local route, the District Bridge Engineer is to report the situation to BIS. BIS will review the incident and report as needed to the Executive Staff. Serious bridge/structure incidents include, but are not limited to:

- Distress in primary structural members to the point where there is doubt that the members can safely carry the loads for which they are subjected, and partial or complete failure of the bridge is a possibility.
- Scour at or under the substructure is such that significant movement is likely which could cause the bridge to collapse.
- Abutment movement or distress that is so excessive that there is a clear possibility that it may not be capable of supporting the superstructure and partial or complete failure is a possibility.
- Suspected cracks in pins or hangers of two girder or truss bridges.
- Fire on or under the bridge, vehicle collision damage, or other man-related damage.

- Collapse or failure of highway-related structures such as noise walls, sound walls, retaining walls, sound structures, etc.
- Any bridge related incident that creates a significant traffic accident or congestion on the Interstate system or expressways.
- Any bridge-related incident involving a vehicle with a Heavy Hauling Permit.
- Any situation where the structural integrity of the bridge is such that its safety is in question.
- Failure of critical systems or components of critical systems within a tunnel.

The purposes for this bridge emergency reporting process include:

- To establish a direct communication link between the District, Central Office, and Incident Management as the problem unfolds, providing the latest information to the Executive Staff; and in the case of emergencies involving the NHS, to the FHWA.
- To determine if appropriate steps for bridge safety are being taken by Districts or Locals.
- To provide timely, additional resources (e.g., technical assistance, emergency funding) to the District if needed.
- Builds a statewide expertise in resolving emergencies that will save time and money on future problems.

Appendix IP 02-G gives additional guidance for inspection following various emergency events including a sample flow chart for communication during a bridge emergency, inspection guidelines following a seismic event and guidelines for post-fire bridge evaluation.

BRIDGE PROBLEM REPORTS: The Bridge Problem Report (BPR) form will be the standard method of documenting bridge and structure problems. The purpose of the BPR is to present a concise "news" report to executive staff and other critical responders on a bridge incident as it unfolds. It is not intended to be a final report on a problem, but a method to provide timely, key information to those who may be part of the response team, including:

- Deputy Secretary for Highway Administration
- Chief Bridge Engineer
- Traffic Engineering and Permits Section
- Director, Bureau of Project Delivery
- Director, Bureau of Maintenance & Operations
- Federal Highway Administration (Bridge Section)

The completed BPR form is sent to the Deputy Secretary for Highway Administration and other key staff as soon as possible. Location maps and available photos or sketches are attached to the BPR. BIS will maintain a database of BPRs for additional study.

The BPR form and guidelines for completing the BPR are in Appendix IP 02-B.

2.9.2 Instructions for Reporting Bridge and Structure Emergencies Using the BPR

1. The District Bridge Unit is to contact BIS by telephone as soon as a problem is known to alert Central Office of a situation that may be unfolding. This allows BIS to understand the nature of the problem, determine the need for reporting to up-line staff and begin marshalling resources that may be needed.

2. BIS determines immediately if a BPR is to be filed and informs the District if additional information is needed.

3. The District provides additional information to complete the BPR. BIS is to complete the BPR form in the same business day the initial reporting was made, but no later than 24 hours. E-mail the required information to the Bridge Inspection Section Chief. Digital photographs are extremely effective in quickly demonstrating the problem.

4. If additional information becomes available or when follow-up tasks are completed, the District Bridge Unit will forward the information to BIS. BIS will provide a follow-up BPR as appropriate.

2.9.3 Emergency Bridge Restrictions and Special Hauling Permits

When a bridge is no longer able to carry its intended loads, it is imperative for public safety to prevent further damage or collapse by controlling traffic on the bridge. The need to prevent overloads on a weakened bridge justifies a thorough and urgent response.

For such situations, the Department may impose emergency restrictions on the bridge that include closing, vehicle weight restrictions, lane closures, prohibition of permitted vehicles, and other traffic control deemed necessary. The emergency actions (determined by the District Bridge Engineer) depend upon the bridge conditions and, in large part, the likelihood of overloads. Because Special Hauling Permits are issued in advance of the actual move, it is more difficult to prevent overloads by heavy vehicles with previously-issued permits than traffic generally. When emergency bridge restrictions are needed, the Emergency Bridge Restrictions and Special Hauling Permits Action Plan is to be followed. A copy of the Action Plan is in Appendix IP 02-C.

The nine steps in the Action Plan can be summarized into 3 main activities:

1. The District Bridge Engineer determines the need and type of an emergency restriction based upon accident reports, bridge inspection reports, bridge analysis/rating, etc.
2. The District Bridge Engineer meets with other members of the ad hoc team of District managers to ascertain other ramifications of the emergency and assign resources to resolve the issues.
3. Physical restrictions are put in place while APRAS restrictions are implemented.

Department Permit and Bridge staffs have gained experience by addressing past emergency bridge restrictions and the Action Plan was developed by the Motor Carrier Division as a result. This Action Plan identifies up to nine steps that may be needed to improve response time and communication to motor carriers operating under various Permits when there is a future emergency bridge restriction, particularly when the affected bridge is carrying an Interstate highway or major Traffic Route.

It is anticipated that all nine steps will need to be pursued in response to an emergency bridge restriction when the bridge is carrying an Interstate highway or major Traffic Route.

2.9.4 Bridge or Tunnel Collapse

All bridge, structure or tunnel collapses are to be reported immediately to the Secretary and the Deputy Secretary for Highway Administration. BIS will report such failures to the Executive Staff based on information received from the Districts.

In the event of such a failure, the District is to establish a “Structure Collapse Team” to investigate the cause(s). The procedures for such teams have been established in the Department Publication 220, "Bridge Collapse or Tunnel Failure Board of Inquiry Investigation Teams".

PUBLICATION 220: Publication 220 is intended to serve as a handy reference for guidelines and actions to be taken in the event of a bridge collapse or failure of a tunnel’s structural components. It includes names of District and Central Office personnel nominated by the Districts and the Central Office to be responsible to respond to emergencies. These persons are to collect facts, report findings and highlight issues to improve bridge and tunnel safety practices.

Home and cellular telephone numbers are also included in Publication 220 to facilitate contact during emergencies. Because of the personal nature of these phone numbers, Publication 220 is considered to be confidential to pertinent Department personnel and is not available for public release. The Bureau of Project Delivery (BOPD) is responsible to update the names and phone numbers in Publication 220 annually.

The District maintenance and construction staffs are to be aware of the importance of a structural failure investigation and are to be instructed not to move or remove debris from the site, if possible. This evidence is extremely important in determining the causes of failure.

In the event of a bridge collapse or the closure of a structure or portion of a structure on an interstate or a structure with a significant impact on the traveling public, immediately contact BIS with as much structural information as is available.

2.10 INSPECTION OF NON-HIGHWAY BRIDGES AND STRUCTURES OVER STATE ROUTES

This section is applicable to all non-highway bridges and structures, except railroad bridges and sign structures over State Routes and retaining walls. See IP 1.7.3 for a general discussion of the Department's and owner's responsibilities for inspection. The technical requirements for safety inspection of railroad bridges, sign structures and retaining walls are contained in IP 2.8, IP 2.11 and IP 2.15 respectively.

For the purposes of this manual, the term "overhead bridge" will be used to encompass all types of non-highway bridges and structures over a public highway.

2.10.1 General Requirements for Overhead Bridge Inventory

INVENTORY REQUIREMENTS: NBIS requires that all bridges or structures greater than 20 ft in length over Public Roads are to be inventoried and their data stored in the Department's BMS2. All bridges or structures, regardless of their length, over State Routes are to be inventoried and their data stored in BMS2.

Other miscellaneous structures over or alongside State Routes are to be inventoried in BMS2 as follows:

1. Cantilever and Overhead Sign Structures – inventory in BMS2.
2. Retaining Walls – inventory in BMS2.
3. High-Mast Lighting – may be inventoried in BMS2.
4. Utility and other structures (e.g., Pipe trusses, conveyor belts) – inventory in BMS2.
   Minor structures with vertical clearance greater than 18 ft. may be exempted from inventory in BMS2 at the discretion of the District Bridge Engineer.
5. Traffic signal standards, lights, and other such items – do not inventory in BMS2.

AGREEMENTS GOVERNING THE CROSSING: The District is to ensure that the non-highway bridges over State Routes and those bridges not involving railroads are governed by a formal agreement between the bridge owner and the Department. The appropriate type of agreement, either HOP (Highway Occupancy Permit) or HOA (Highway Occupancy Agreement), is to be used at each bridge. The responsibilities of the owner should be clearly outlined in the agreement. Also, the agreement is to outline provisions for the inspection of the bridge and recoupment of costs by the Department in the event the owner fails to inspect the bridge and report the same to the Department in a timely manner.

For non-railroad bridges, record and maintain the appropriate HOA or HOP identification number in the BMS2 Item VM05 PSC-PUC Number for the appropriate governing document with the following instructions:

- <u>HOP or HOA bridges</u>:
  Digits 1-3: Enter HOP or HOA
  Digits 4-11: Enter identifying HOP/HOA Number

- <u>For other agreements (written or informal)</u>:
  Digits 1-3: Enter XXX
  Digits 4-11: Enter number associated with agreement. If none, enter 99999

2.10.2 General Requirements for Overhead Bridge Safety Inspections

The inspection of these non-highway bridges is similar to Routine Inspections of highway bridges. Because of the many types and features of existing overhead bridges, this section cannot list a complete set of specific inspection requirements. The scope of work for inspection of these overhead bridges is to be detailed in the agreement document (HOA, HOP, etc.) governing the crossing.

The General Scope of Work for the Safety Inspection of State and Local Bridges contained in Appendix IP 01-F is to be used and adapted as the inspection specifications for each individual structure. See Appendix IP 01-I for minimum inventory and inspection items required for overhead bridges which is less than the requirements for

State and Local Bridges. The specific scope of safety inspections for an overhead bridge or structure, including any needed load ratings, must be acceptable to the District Bridge Engineer.

Load ratings are considered part of the overhead bridge inspection process just as they are for highway bridges. If appropriate, underwater inspection requirements for substructures should be included. Overhead bridge safety inspection reports must be signed and sealed by a Pennsylvania Professional Engineer.

For longer bridges and structures, the inspection report to the Department may be limited to only those spans over the highway ROW and the substructure units supporting those spans. The District Bridge Engineer must approve the elimination of portions of a bridge from these inspection requirements. Bridge owners are encouraged, but not required, to inspect remaining portions with the same intensity.

For building-to-building passageway bridges, the structural components may be covered by siding, masonry, etc., that would interfere with an inspection using normal bridge techniques. These architectural facades also prevent the deterioration normally suffered by bridge components exposed to the weather. The scope of these inspections must be developed on a case-by-case basis.

Safety inspection reports and data of all bridges over State Routes must be submitted to the Department for its review and acceptance.

While this section was developed for bridges over State Routes, other roadway owners are encouraged to adopt it for use for non-highway bridges over their roadways.

2.10.3 Interval of Overhead Bridge Safety Inspections

All bridges and structures, not including sign structures or retaining walls, over State Routes are to have a bridge safety inspection on an interval no greater than 24 months. The District Bridge Engineer, at their discretion, may require inspections more frequently than 24 months if structure and/or site conditions warrant.

The inventory data for all bridges and structures over State Routes shall be verified on an interval no greater than 24 months. An inspection of the highway environs of the bridge is to be made at the same time.

2.11 SIGN STRUCTURE SAFETY INSPECTIONS

The purpose of the sign structure safety inspection program is to verify each sign structure’s inventory data, to determine its physical condition and maintenance needs and to record the same in the Department’s BMS2.

These guidelines are to provide methodology and procedures for those inspections.

2.11.1 Types of Structures

Sign structures are typically constructed of either galvanized steel or aluminum. There are also some painted and unpainted weathering steel structures.

The five basic types of sign structures in PA are as follows:

OVERHEAD - 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, tubular, and rigid frame structures.

CANTILEVER - consisting of one or more horizontal members supported at only one end.

CENTER MOUNTED - consisting of one or more horizontal members supported at the center.

POLE-MOUNTED –Used exclusively for VMS, with a mounting plate on top of a single column support.

STRUCTURE MOUNTED - a sign attachment permanently mounted to the fascia beam and/or parapet to be visible to traffic beneath the bridge as shown on attached sketch. These signs are typically inspected during the bridge's NBIS inspections. Particular attention must be given to sign attachments made using powder actuated methods and materials.

Cantilever or Overhead Sign Structures that are mounted on bridge piers, barriers, brackets, etc., are to be classified as such and not as Structure Mounted. They should be inventoried separately from bridges.

2.11.2 Types of Sign Structure Inspections

All Sign Structure inspections shall be coded in BMS2 Item 7A03 as S-Sign Structure. Item IS01 in BMS2 allows for the coding of one of five sign structure inspection types, all of which include close visual and hands-on examination of the sign structures. A brief description of each of these is given below:

INITIAL INVENTORY (BMS2 Item IS01 = A) - This type of inspection provides for the collection of a sign structure's inventory data for entry into the Bridge Management System 2 (BMS2). All items included on *i*Forms Form S must be completed. This work includes an In-depth inspection as described below.

IN-DEPTH (BMS2 Item IS01 = B) - A close visual and hands-on examination of each component, member, fastener, and weld on the structure and/or non-destructive field tests and/or material tests are performed to fully ascertain the existence of or the extent of any deficiency. Lane closures are anticipated to permit access to all portions of structure.

IN-DEPTH (Alternate Lanes Closed) (BMS2 Item IS01 = C) – This type of inspection involves a close visual and hands-on examination of column bases, end supports, or selected portions of horizontal members. Areas of horizontal members to have close hands-on inspection and/or non-destructive field tests and/or material tests performed to fully ascertain the existence of or the extent of any deficiency, are selected to provide overall safety while minimizing traffic disruption. Existing inventory data is to be updated.

ROUTINE (BMS2 Item IS01 = D) - A close visual and hands-on examination of all portions of the sign structure. Lane closures are anticipated to permit access to all portions of structure. Ladders can be used to access end supports away from traffic. Existing inventory data is to be updated.

SPECIAL INSPECTIONS (BMS2 Item IS01 = E) - This type of inspection will be performed to provide in-depth assessment of special conditions when significant structural deficiencies, severe section loss, collision damage, or corrosion have been noted. These inspections will be performed as directed by the District Bridge Engineer.

Inspection types Routine, In-depth and Special Inspections are performed subsequent to the initial inventory inspection and involve only a cursory review of the inventory data to verify correctness. These four different levels of effort can be used to evaluate the sign structure based on its condition and inspection history.

2.11.3 Inspection Frequencies and Typical Cycles

The interval of inspection and level of inspection intensity for Overhead and Cantilever sign structures are influenced by structure material, structure type, condition and age. Table IP 2.11.3-1 establishes the inspection frequencies for the various sign structures. Structure-mounted sign structures are to be inspected along with the other bridge components as part of the biennial NBIS safety inspections. Table IP 2.11.3-2 lists the Typical Cycles for conduction of Safety inspection for different sign structure types and varying conditions.

Table IP 2.11.3-1 – Sign Structure Routine Inspection Interval	
STRUCTURE TYPE	**INSPECTION INTERVAL**
ALUMINUM OVERHEADS	2 YEARS
GALVANIZED STEEL OVERHEADS	
COND. ≥ 5	6 YEARS
COND. ≤ 4 or BUILT PRIOR TO 1995	3 YEARS
MOUNTED ON BRIDGES	2 YEARS
GALVANIZED STEEL CANTILEVERS	
GROUND MOUNTED	6YEARS
MOUNTED ON BRIDGES	2 YEARS
STRUCTURE MOUNTED	*2 YEARS

NOTE: IN-DEPTH INSPECTION SCHEDULED ON AN AS NEEDED BASIS AND INCLUDES ADVANCED DETECTION TECHNIQUES

*STRUCTURE MOUNTED SIGNS ARE INCLUDED AS PART OF A BRIDGE INSPECTION

Table IP 2.11.3-2 – Sign Structure Inspection – Typical Cycles						
STRUCTURE TYPE	**YEAR**					
	1	**2**	**3**	**4**	**5**	**6**
ALUMINUM OVERHEADS	X	—	X	—	X	—
GALVANIZED STEEL OVERHEADS						
COND. ≥ 5	X	—	—	—	—	—
COND. ≤ 4 or BUILT PRIOR TO 1995	X	—	—	X	—	—
MOUNTED ON BRIDGES	X	—	X	—	X	—
GALVANIZED STEEL CANTILEVERS						
GROUND MOUNTED	X	—	—	—	—	—
MOUNTED ON BRIDGES	X	—	X	—	X	—
STRUCTURE MOUNTED	X	—	X	—	X	—

2.11.4 Field Inspection Procedures

The General Scope of Work for the Safety Inspection of Sign Structures is in Appendix IP 02-D. Many of the techniques from bridge inspection are also applicable for sign structures. Use appropriate portions of these guidelines and bridge inspection procedures to inspect Structure-Mounted signs.

2.12 ADJACENT NON-COMPOSITE PRESTRESSED CONCRETE BOX BEAMS

The December 2005 collapse of a fascia beam on the bridge carrying State Route 1014 over Interstate 70 in Washington County resulted in a review of the procedures and practices used in the safety inspection and load rating analysis for adjacent non-composite prestressed concrete box beam bridges.

The bridge had four simple spans with a bituminous wearing surface (without a waterproofing membrane). There had been considerable damage to the failed fascia beam and interior beams due to overheight vehicle collisions. Through the years, the loss of additional prestressing strands occurred due to continuing corrosion. Some of this strand loss was not detectable using routine visual inspection methods. The result was that the fascia beam collapsed under its own weight.

As a result of this review and studies of the failed beam conducted by the University of Pittsburgh and Lehigh University, the following sections of this Manual have been modified or added:

- Field Inspection Guidelines: For guidelines on inspection procedures and documentation of findings, see IE 4.3.5.6.3.1I.
- Load Rating: For guidelines on general requirements, see IE 6.1.5.3I. For distribution of barrier dead load, see IE 6B.6.1. For distribution of live loads, see IE 6B.6.3. Load ratings by Engineering Judgment per Appendix IP 03-B is no longer permitted for adjacent non-composite prestressed concrete box beams; see Appendix IP 03-B Applicability of Guidelines for more information.

2.13 STRUCTURE MAINTENANCE NEEDS

Maintenance needs for bridges and other structure types are to be identified and recorded during the safety inspection process. The inspectors are to recommend maintenance activities and the priority of their need based upon the conditions in the field. The maintenance needs and priorities recommended from the field must be reviewed to account for information that may not have been available in the field, including:

- Anticipated deterioration rate and its expected impact on structural safety.
- Implications for changes in load rating capacity and/or structural stability.
- The effect of mitigation efforts, including planned or current traffic restrictions, to ensure public safety.
- The level of confidence in condition information, as modified by interval of inspection, potential for hidden deterioration, structural redundancy or complexity, etc.

The condition rating and maintenance priority descriptions are provided in the BMS2 Coding Manual, Publication 100A.

2.13.1 Proposed Maintenance Needs in BMS2

The proposed maintenance needs identified by safety inspections are to be recorded in BMS2 as Flexible Actions using the list of standard maintenance activities in the BMS2 Coding Manual, Publication 100A. These maintenance items are subdivided into the following four categories for maintenance planning purposes and Department performance measures:

Bridge	Activities that generally have either high or medium value payoff benefit for maintaining bridge structural component repair and/or replacement.
Tunnel	Activities that generally have either high or medium value payoff benefit for maintaining tunnel component repair and/or replacement.
Other Structural	Activities that generally have low value payoff benefit with respect to maintaining bridges or pertain to another structure type (i.e. sign structures).
Bridge Cleaning	Bridge and structure cleaning activities.

The bridge maintenance category and value payoff benefit was determined by its relative impact on the life cycle costs of maintaining bridges. Accordingly, these categories and payoff values do not correspond directly to assignment of maintenance priorities, especially for Priority 0 or 1.

2.13.2 Critical and High Priority Maintenance Items

Critical and High Priority Maintenance Items are valid for all structure types except for tunnels. For tunnel maintenance categories see IP 2.13.3.

Critical (Priority 0) or high (Priority 1) priorities (BMS2 Item IM05) for maintenance activities are defined as having deficiencies that threaten either the structural integrity of the bridge (or other structures) or public safety. This limits the application of Priority 0 or 1 to those activities to correct such deficiencies. Damaged or missing vertical clearance or load limit signs are examples where there may be no immediate structure safety problem, but where public safety is compromised, and immediate action is required. It follows that maintenance activities such as painting and cleaning may have a high value payoff benefit for life cycle costs but should not warrant a Priority of 0 or 1. There may be situations where activities in Other Structural category of maintenance activities may warrant Priority 0 or 1.

Bridges with a superstructure, substructure, deck, culvert or SCBI condition rating of a 2 or less shall also have a critical or high priority maintenance item that will target the cause of the low condition rating. As indicated in IP 2.14 and IP 6.2, these bridges require a Plan of Action (POA) and review by the District Bridge Engineer before a bridge inspection can be moved into "Accepted" status.

The BMS2 Coding Manual, Publication 100A further details the IM05 coding instructions and provides further examples.

In general, the conditions that create the recommendation for Priority 0 and Priority 1 maintenance items would warrant the development of a Bridge Problem Report (BPR). The District should notify the Bridge Inspection Section of the problem immediately and the determination of the need for a BPR will be made.

Because of the threat to structural and public safety they pose, the following additional actions are required for Department bridges (or structures) with maintenance activities that warrant a critical or high priority (IM05 = 0 or 1 respectively):

- **Approval by District Bridge Engineer –** The inspection and maintenance recommendations must be immediately reviewed by the District Bridge Engineer to determine the appropriate mitigation and restoration for the deficient condition.
- **Approval by County Maintenance Manager –** After approval by the District Bridge Engineer, the County Maintenance Manager shall review and accept the POA maintenance activities and ensure the activities are completed.
- **Plan of Action for resolving the critical deficiencies** – See IP 2.14

For non-Department bridges (including those owned by municipalities, counties and other agencies), critical or high priority maintenance needs pose the same possible threats to public safety. In the Department's overarching role and responsibilities for the safety of public highway bridges, the District must take additional steps to see that the bridge owner has had the public safety issues fully explained to them along with the need to take appropriate action to mitigate or correct them.

- The standard scopes of work for bridge safety inspection agreements require the inspector to notify the owner of such critical deficiencies and also conduct a meeting to discuss all critical structural and safety related deficiencies. As part of the meeting to discuss these critical deficiencies, the consultant shall prepare a Plan of Action (POA) in coordination with the local owner (see Appendix 01-F, G and H). The District (also a recipient of the critical deficiency notice) is to contact the owner by telephone call, personal visit, or correspondence (e-mail) to determine if the owner's plan for repair is timely and sufficient. To properly convey the significant public safety issues, this District contact person should be the District Bridge Engineer or other Professional Engineer. The District Municipal Services staff may also be helpful during this contact and by attendance at the meeting to discuss the critical deficiency. The meeting and POA development shall be within three (3) calendar days from the date the critical structural or safety deficiency is discovered. For high priority structure deficiencies, the meeting and POA must be conducted within seven (7) days.

- While critical deficiencies can exist for bridge-related signs as indicated above, they do not warrant a meeting or POA since the necessary corrective action regarding signs is sufficiently clear. However, the requirements for notification described above remain in effect.
- If the proposed action by the owner is not deemed sufficient, additional District actions may be necessary to ensure public safety, up to and including closing the bridge. The District is to immediately contact the Bridge Inspection Section Chief if an owner is not taking timely action and before restricting a bridge without the owner's consent as indicated in IP 1.7.2.4 and IP 4.7.2.
- The non-Department bridge owners are required to follow the full POA process as described herein. The POA process in BMS2 is a good way for them to document their actions for critical bridge deficiencies.

2.13.3 Tunnel Maintenance Categories

As indicated in the TOMIE, there are three main categories for tunnel maintenance items. Critical Findings would be labeled as a Priority 0, Priority Repairs would be Priority 1, 2 or 3 and Routine Repairs would be Priority 4 or 5 maintenance items in BMS2. See TOMIE Section 4.12.2.4 for additional information.

2.13.3.1 CRITICAL FINDINGS

Critical findings for tunnel inspection are structural or safety related deficiencies that require immediate action and must be reported in accordance with the NTIS. Critical findings and mitigation measures shall be well documented through field notes and photographs. All documentation, including detailed descriptions and photographs, shall be made available to FHWA during the reporting process. Critical findings typically require the following action be taken in a timely manner:

- Closure or restriction until the severe defect is removed or repaired, if the defect may impact users or user safety.
- Repair the structural member or address the functional or safety issue.

It is the responsibility of the team leader on site to identify critical findings and notify the owner as soon as possible. The tunnel owner shall follow the written procedure established in the tunnel inspection agreement when a critical finding is identified to ensure FHWA is notified within 24 hours of the initial finding. Depending on the type of finding, others may need to be notified as well such as tunnel maintenance personnel.

Once the critical finding has been identified and reported, future steps shall be identified and recorded to monitor or mitigate the concern. For example, if the strength or serviceability of the tunnel could be at risk, a structural review or systems analysis may be required. A follow-up inspection may also be required.

The PennDOT Program Manager will submit an annual report to FHWA detailing all the tunnel critical findings which were reported within the prior calendar year as well as mitigation measures taken.

2.14 PLAN OF ACTION FOR CRITICAL AND HIGH PRIORITY MAINTENANCE ITEMS, BRIDGES IN CRITICAL CONDITION AND TUNNELS WITH CRITICAL FINDINGS

Because of the risk to public safety, a Plan of Action (POA) is required for all recommended maintenance activities with a Priority 0 or 1 for both Department and non-Department bridges (or structures). A POA is also required to address all critical findings resulting from tunnel inspections. The POA must identify the action(s) to be taken to repair and/or mitigate the deficiency that warranted the critical or high priority recommendation.

The BMS2 Coding Manual, Publication 100A, in the general condition ratings, defines critical condition as a condition rating equal to a two (2) for the following components; deck, superstructure, substructure, or culvert. Bridges with a Scour Critical Bridge Indicator (SCBI) having a rating equal to a two (2) must have a similar review and evaluation. An April 27, 2001, memorandum from the Federal Highway Administration (FHWA) states the substructure condition rating should be consistent with the one given to the SCBI whenever a rating factor of 2 or below is determined for the SCBI rating. Due to the critical condition of the bridge, a POA is required to ensure public safety and must identify what action(s) will be taken to improve the condition of the structure from a condition rating of a 2. A critical finding and POA is also required when an element is coded in Condition State 4 for a tunnel and possesses an immediate structural or safety related risk.

The processes involved in determining the recommended action and its priority in the safety inspection program and the development and implementation of the POA itself are highly interactive. High levels of communication and cooperation between all parties are necessary to make the required corrective actions occur in a timely manner.

In some instances, the risk to public safety could be imminent and require the bridge inspectors to take immediate actions to close a structure from vehicular and pedestrian traffic. These instances require appropriate action to ensure public safety without putting the safety of the traveling public or the inspectors at risk. Detailed procedures to follow in these instances are provided in Appendix IP 02-F.

2.14.1 Timeframe for POAs

Priority 0 activities are to be resolved or mitigated within 7 days of identification.

- For Priority 0 items, physical action must be taken to resolve the critical deficiency. By definition, this work cannot be deferred. By definition, monitoring alone for Priority 0 items will not suffice.
- The immediate actions taken may not resolve the deficiency but must restore or mitigate the safety problem to an acceptable level, even if level of service must be reduced. Such an example may be to close the bridge immediately until repairs can commence.
- Additional work at a later time may be needed to restore bridge to full service and safety. This additional work may be needed at a Priority 1 level.

Priority 1 activities are to be resolved or mitigated within 6 months.

- Priority 1 requires physical work to correct the deficiency.
- For Priority 1, physical work to correct the deficiencies may be deferred only if other work (e.g., rehabilitation project) is scheduled in the near future and if the condition of the structure will not further degrade and compromise safety before that scheduled work is done.
- In this context, the timeframe for "near future" generally should not extend beyond 2 years unless justification for this exception is provided by the District Bridge Engineer.
- Monitoring alone or in conjunction with repairs may suffice if conditions will not degrade. Monitoring should be quantitative by including measurements of structure, e.g., deflection, crack width, scour depth, etc., and not just description of visual observation. Documentation, including sketches and charts showing changes over time are highly recommended. Documentation of monitoring must be added to BMS2.
- For deferred actions, the POA must provide full justification for the above points.

Bridges in Critical Condition

- Because it is expected that bridges in critical condition will also have critical or high priority maintenance items (i.e., Priority 0 and 1), determine whether these maintenance items are properly identified and addressed with a POA in accordance with IP 2.13 and IP 6.2.4.
- Evaluate the current load rating for the structure and determine if the rating still applies or if a rerating is needed.
- Take appropriate action to post or reduce the posting of a structure, execute repairs in accordance with the POA, or close the bridge when conditions warrant such action.
- For bridges in critical condition with a Scour Critical Bridge Indicator (SCBI) rating of two (2) or less, review documentation of scour measurements from probing or diving to ensure the scour condition is stable and not worsening.
- Update Inspection Maintenance (IM) screen including POA data fields in BMS2 and provide a schedule in IM15b if a high priority maintenance item is deferred.

Tunnels with Critical Findings

- Critical findings shall be handled under the same timeline and rules of a Priority 0 above.
- Critical findings must be reported to FHWA within 24 hours.

- For structural elements, a structural review to determine the effect on strength or serviceability of the tunnel must be completed.
- For non-structural elements, an evaluation to determine the effect on serviceability of the element or tunnel must be completed.
- Regardless of the findings of the review of structural and/or non-structural elements, a POA to mitigate the critical finding must be submitted to the owner, PennDOT and FHWA.

Development and acceptance of a Priority 0, Critical Condition POA or tunnel critical finding POA should be complete within 2 days for 90% of occurrences and within 3 days on 100% of occurrences. Development and acceptance of a Priority 1 POA should be complete within 7 days on 100% of occurrences.

The timeframe for a POA starts on the day of the inspection where deficiency is discovered (BMS2 Field IM06). Generally, the need for critical or high priority maintenance items is determined during a safety inspection. However, if a critical deficiency is found between inspections, an inspection to fully ascertain the condition must be done. This need not be a regular NBIS/NTIS inspection if a special inspection of the problem area only will suffice.

It may be necessary to take immediate actions, permanent or temporary in nature, to safeguard public safety (e.g. temporary shoring, bridge closing) before the POA is fully developed.

Exceptions to the timeline for POA documentation will be considered only for complex problems that take more time to reach a final solution. The District must request a POA documentation time extension via e-mail to the Bridge Inspection Section Chief before the end of day 3. Such extensions to the POA documentation do not extend to implementation of interim or permanent action(s) recommended to secure safety.

2.14.2 Responsibilities for Plan of Action

The responsibilities for the various portions of a POA can be generally described as listed below. It is important to note that the Districts may reassign the POA responsibilities outside the safety inspection program activities to meet the POA requirements as best fits their organization. However, decisions concerning public safety which require the expertise of a professional engineer cannot be reassigned to individuals not duly qualified.

<u>District Bridge Engineer</u>

- Determination of Critical or High Priority Maintenance Recommendations
- Development of POA and concurrence with actions.
- Development of repair plans, as needed
- Input and maintenance of BMS2 data
- Status Reports to Bridge Inspection Section
- Safety inspection of completed repairs

<u>District Bridge Maintenance Coordinator</u>

- SAP Notifications and Work Orders
- Coordination of Department Force efforts
- Other duties as assigned

<u>County Maintenance Manager</u>

- Review and acceptance of POA
- Initial emergency response and traffic control activities
- Management of Department forces
- Procurement of materials and equipment
- Schedule and provide resources to meet the POA needs.
- Status reports to District Bridge Engineer
- SAP data entry

<u>Other District Responsibilities</u>

- Procurement of Contractor Services
- Management and QC of construction activities
- Public information

- Funding

<u>Bridge Inspection Section and Bridge Design and Technology Division</u>

- Status reports to Executive staff
- Technical assistance
- Summarize the critical finding and response plan for the annual FHWA report

<u>Tunnel Owner</u>

- Report critical findings to PennDOT in a timely fashion such that FHWA will receive notification within 24 hours
-

2.14.3 The POA Development Process

A general flowchart of the processes involved in the development of a POA is shown in Figure IP 2.14.3-1. The description of the POA flowchart steps is provided in Figure IP 2.14.3-2 (3 pages).

The POA must contain sufficient detail to outline responsible party, estimated start and completion dates, and estimated costs for actions steps.

2.14.4 POA Data in BMS2

The Proposed Maintenance tab of the IM screen (Inspection-Maintenance) of *i*Forms, as well as the Proposed Maintenance Screen in BMS2 have data fields to record the limited data items to document and track POAs for Critical and High Priority maintenance activities as well as critical findings for tunnels. Guidance for the data items are provided in the BMS2 Coding Manual, Publication 100A. The District shall upload documents regarding the POA into BMS2 via the Documents link.

Bridges with critical and/or high priority maintenance items or tunnels with critical findings will require the maintenance items to have complete information for the POA in BMS2 before the inspection can be accepted. These fields include IM14b – POA Date, IM14c – Mitigation Date (if mitigated from a P0 to a P1), IM15c – Bridge Approver, and IM15d – Maintenance Approver.

2.14.5 Status Reports for POA Activities

The District is responsible to ensure that the BMS2 data items relating to the POA and status of corrective activities are maintained and up-to-date. The Bridge Inspection Section will monitor this data for compliance with Department policies.

Upon the acceptance of the POA by the District Bridge Engineer and the County Maintenance Manager, the District is to submit a copy of the POA to the Bridge Inspection Section Chief via e-mail.

Upon completion/mitigation of Priority 0 items, the District Bridge Engineer is to notify the Bridge Inspection Section Chief via e-mail that these critical tasks are complete. This notification will also serve as documentation for completion of needed activities identified in the Bridge Problem Report. Additionally, IM14a – Completion Date for the maintenance item should be completed in BMS2 or *i*Forms.

For bridges or problems of special interest, the Bridge Inspection Section Chief may request more frequent status reports of work activities/completion.

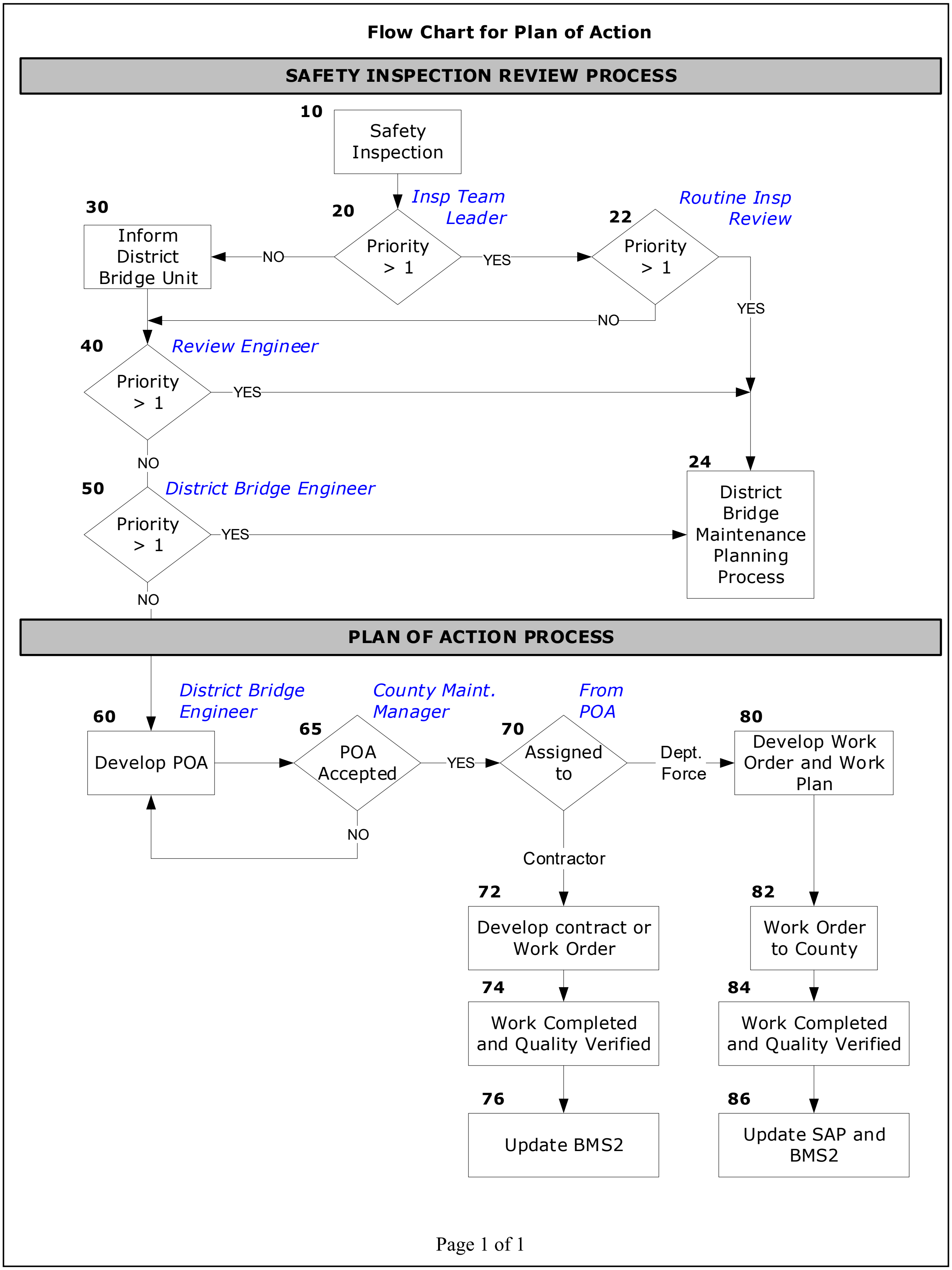

Figure IP 2.14.3-1

Plan of Action Flow Chart - Steps

SAFETY INSPECTION REVIEW PROCESS

STEP 10 Safety Inspection

- For inspections performed by consultant or Department forces.

STEP 20 Field Review of Recommended Maintenance

- Review performed by Team Leader
- Team Leader is to determine if any Maintenance item is recommended at a Priority of 0 or 1.
- If any recommended bridge maintenance items have a Priority of 0 or 1, the Team Leader is to contact District Bridge Unit immediately.
- If no Priority 0 or 1 items are identified, inspection proceeds to routine review process.

STEP 22 Routine Inspection Review

- Review performed by Reviewer at District Bridge Unit
- If the review results in any maintenance items being elevated to Priority 0 or 1, the inspection must go to Step 40.
- If no Priority 0 or 1 items are identified, maintenance recommendations proceed to routine District bridge maintenance planning process.

STEP 24 District Bridge Maintenance Planning Process

- This is the normal process used by the District to plan maintenance.

STEP 30 Team Leader Informs District Bridge Unit

- The Team Leader makes all inspection information, including field report and photos, available to the District Bridge Unit.

STEP 40 Review Engineer Review of Inspection

- The inspection and recommended maintenance is reviewed in District Bridge Unit.
- If Critical or High priority items are recommended by the inspectors, this review must be done by a registered PE.
- If the review results in no maintenance items receiving Priority 0 or 1, the Review Engineer may accept the inspection in BMS2 and all recommended maintenance proceeds to routine planning process.
- If critical or high priority items remain, the inspection must be reviewed by the District Bridge Engineer.

STEP 50 Bridge Engineer Review of Inspection

- The inspection report and recommended high priority maintenance items are reviewed by the District Bridge Engineer.
- If this review results in no maintenance items receiving Priority 0 or 1, the Bridge Engineer accepts the inspection in BMS2 and all recommended maintenance proceeds to routine planning process (Step 24).
- If critical or high priority items remain, the District Bridge Engineer is to develop a POA to resolve and/or mitigate the deficiencies (Step 60).
- If immediate emergency action is required for public safety, the County Maintenance Manager is to be informed immediately and appropriate work initiated. Do not wait for formal POA to be adopted for these immediate actions to be started.

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Figure IP 2.14.3-2

PLAN OF ACTION PROCESS

STEP 60 Develop the POA for Critical and High Priority Items

- **For Priority 0 items**, physical work is needed to resolve the critical deficiency. By definition, this work cannot be deferred.
  - Immediate actions may include closing or posting the bridge, restricting traffic from the damaged areas, temporary shoring, etc. These actions may not completely resolve the deficiency but must restore the structure safety to an acceptable level.
  - Additional work at a later time may be required to more fully restore safety and level of service. This later work and schedule should be included in POA.
  - If initial immediate actions bring the bridge safety to an acceptable level, the priority for remaining permanent repair work may be downgraded to 1.
  - Priority 0 items are to be resolved within 7 days of inspection.
- **For Priority 1 items**, physical work to correct the deficiencies may be deferred only if the needed repair, rehabilitation or replacement is scheduled such that public safety is not compromised in the interim.
  - Similar to the description in Priority 0 items, the POA for repairs may involve immediate actions followed by additional work.
  - Deferred repairs must be justified in the POA and recorded in BMS2.
  - Priority 1 work items are to be resolved within 6 months.
- Where emergency traffic restrictions are used, use the procedures outlined in Pub 238 Appendix IP-02C.
- Monitoring may be required to ensure ongoing safety until work is complete. Monitoring results must be documented in BMS2. Monitoring alone is not sufficient for Priority 0 deficiencies.
- The POA is to include:
  - Scope of physical and/or design work
  - Estimated Costs
  - How work is to be performed (Contractor or Department forces)
  - Timeframe to completion

STEP 65 Acceptance of POA by County Maintenance Manager (CMM)

- County Maintenance Manager reviews draft POA for acceptance.
- In extreme situations, the POA may not be fully developed before initial actions have to be taken.
- If acceptable, the CMM is to inform District Bridge Engineer immediately.
- If not acceptable, CMM is to offer suggestions for changes.
- If the DBE and CMM cannot reach a timely agreement on the POA, the ADE-Maintenance and ADE-Design are to be consulted. Because of the public safety issues, the final decision on actions and recommended plans must be approved by a professional engineer.

STEP 70 Assignment of Activities

- District to assign activities to contractor and/or Department Force as outlined in POA
- The District Bridge Unit is to update BMS2 accordingly.
- For work assigned to Department Force, go to Step 80.
- For work assigned to contractor, go to Step 72

STEP 72 Develop contract or Work Order

- Responsibility for this activity to be assigned by the District.

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Figure IP 2.14.3-2

PLAN OF ACTION PROCESS (cont.)

STEP 74 Contractor Work Completed and Quality Verified

- QA/QC construction duties to be assigned by District. The District Bridge Engineer must be informed when the work has been completed by contractor or department forces.
- Special inspection of repairs to be made by District or consultant.

STEP 76 Update BMS2 data

- Responsibility for this activity to be assigned by the District.

STEP 80 Develop Work Order and Work Plan

- Bridge Maintenance Coordinator to work with Bridge Unit to create Work Order for the Department Forces

STEP 82 County notified of new work through SAP

- Notification to SAP to be generated in BMS2

STEP 84 Department Force Work Completed and Quality verified

- QA/QC construction duties to be assigned by District
- Special inspection of repairs to be made by District or consultant to verify satisfactory completion of the critical or high priority work and to update BMS2.

STEP 86 Update BMS2 Data

- Responsibility for this activity to be assigned by the District.

Communication and tracking

- During a bridge emergency, good communication is vital to teamwork and ultimate success of mission.
  - Use e-mail and other forms of electronic communication to expedite transfer of critical information between team members.
  - Communication of work status to Bridge Inspection Section Chief is vital in order that technical assistance and oversight may be made expeditiously.
- The District is responsible to track the progress of POA in BMS2.
- The District Bridge Engineer will be responsible to provide timely status updates to the Bridge Inspection Section Chief and Chief Bridge Engineer.
- The Bridge Inspection Section Chief or the Chief Bridge Engineer is responsible for required reports to Executive Staff.

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Figure IP 2.14.3-2

2.15 RETAINING WALLS

The purpose of the retaining wall safety inspection program is to verify each retaining wall's inventory data, to determine its physical condition and maintenance needs, and to record the same in the Department's BMS2. The inspection typically consists of an examination and recording of signs of damage, deterioration, movement, and if in water, evidence of scour.

To achieve a minimum 100 year service life for retaining walls, the walls should be inspected/monitored on a regular basis as described in IP 2.15.3 to identify and address specialized issues and receive routine preventative maintenance, preservation, and rehabilitation. That is, both maintenance and inspection are vital to ensuring the longevity and performance of retaining walls.

The inspection of retaining walls is required for walls that have their own S-number. Wingwalls of a bridge are included with the inspection of the bridge.

2.15.1 Types of Retaining Walls

Retaining walls typically have a material type of steel, concrete, timber, masonry or stone. Many structural configurations of retaining walls exist such as cantilever, gabion, Mechanically Stabilized Earth (MSE), tie-back, and concrete modular walls, etc.

2.15.1.1 MECHANICALLY STABILIZED EARTH WALLS

Mechanically Stabilized Earth (MSE) retaining wall systems have three major components:

- Soil reinforcement (mesh or strip) – The soil reinforcement is described by the type of material used, the soil reinforcement geometry, and the connection method to the precast facing panels.
- Backfill - The backfill used within the reinforced zone is granular to meet stress transfer, durability, and drainage requirements.
- Precast facing elements - Facing elements are provided to retain fill material at the face. Typical facing elements include precast concrete panels with or without architectural treatments, extruded metal sections or timber.

In addition to the three major components, several other components are typical to MSE retaining walls:

- Leveling pads - Note: Leveling pads are non-structural footings used at the base of the wall as an aid in construction.
- Barriers - Barriers supported by moment slabs are common on top of MSE retaining walls to protect traffic traveling on a parallel roadway.
- Expansion joints - Vertical slip joints are required for expansion for long lengths of walls.

Neither reinforcement nor backfill will be able to be inspected; therefore, a close visual inspection of the facing panels and drainage facilities is required to provide information on all three of the major components. This includes visual inspection of the roadway surface (i.e., pavement) above the MSE wall for tension cracking. Inspection of the leveling pads, if visible, can provide information on scour, erosion or settlement. Inspection of the barriers can also provide important information regarding movement of the MSE wall.

2.15.2 Types of Retaining Wall Inspections

All retaining wall inspections shall be coded in BMS2 Item 7A03 as T-Retaining Wall. The specific type of inspection for the retaining wall should be indicated in BMS2 in the Inspection Applet Item IW01. The following are four inspection types, all of which include close visual and hands-on examination of retaining walls. A brief description of each of these is given below:

<u>INITIAL INVENTORY</u> (BMS2 Item IW01 = F) – This type of inspection provides for the collection of a retaining wall's inventory data for entry into BMS2. For mechanically stabilized earth walls with a length in excess of 100 feet and with at least 20 feet of exposed height, a three-dimensional survey* must also be completed. Refer

to Publication 100A, BMS2 Coding Manual, Section 2.4 for creating new structures. BMS2 screen VW must be completed.

IN-DEPTH (BMS Item IW01 = D) – A close visual and hands-on examination of retaining walls and their drainage systems. Use of down-hole cameras or visual inspection of larger pipes is required for the drainage system. All items included on iForms Forms M, P and W must be completed. For mechanically stabilized earth walls with a length in excess of 100 feet and with at least 20 feet of exposed height, a three-dimensional survey* must also be completed. Existing inventory data is to be updated.

ROUTINE (BMS2 Item IW01 = R) – A close visual and hands-on examination of retaining walls and their drainage systems without traffic control. Those portions which cannot be accessed safely from beyond the edge of pavement are viewed using binoculars and/or a digital camera. All items included on iForms Forms M, P and W must be completed. Existing inventory data is to be updated.

SPECIAL INSPECTION (BMS2 Item IW01 = P) – A close visual and hands-on examination of retaining walls and their drainage systems after a significant occurrence such as a vehicular collision or extreme weather event where heavy prolonged rains or flooding may have occurred. All items included on iForms Forms M, P and W must be completed. Existing inventory data is to be updated.

* The three-dimensional survey should be completed in accordance with the guidelines in the Surveying and Mapping Manual, Publication 122M, Part A Chapter 3 and Chapter 6.7. The Photogrammetry and Survey Section and Multiple Districts have LiDAR scanners with three-dimensional survey capability available for use in the Engineering Districts.

2.15.3 Inspection Frequencies and Typical Cycles

The inspection interval of retaining walls is listed below in Table IP 2.15.3-1. Wingwalls of a bridge are to be inspected with the bridge on the interval defined in Table IP 2.3.2.4-1.

Table IP 2.15.3-1 – Retaining Wall Inspection Frequencies

Inspection Type (IW01)	Type of Inspection	Interval (years)	Comments
F	Initial (First Time)	N/A	Inspection required within 6 months of construction completion or before opening road to traffic, whichever is less
D	In-Depth	10*	For Structural Evaluation (BMS2 item 4A09) ≤ 4. For MSE Walls only: Three-dimensional survey to be completed for walls ≥100’ long and ≥20’ in height
		15*	For Structural Evaluation (BMS2 item 4A09) > 4. For MSE Walls only: Three-dimensional survey to be completed for walls ≥100’ long and ≥20’ in height
R	Routine	5	
P	Special	As required	Performed after a significant occurrence such as a vehicular collision, extreme weather, or indication of wall movement.

* A three-dimensional survey can be requested for MSE Walls at any time when movement of the wall is suspected.

Inspection types, In-Depth, Routine, and Special are performed subsequent to the initial inventory inspection and involve varying levels of effort.

2.15.4 Field Inspection Procedures

Many of the techniques from the bridge inspection are also applicable to retaining wall inspections. Establishing a baseline condition for retaining walls is crucial for effective future inspections.

- Inspect exposed wall faces, barriers and moment slabs, footings and joints for: arching, spalling, movement of joints, corrosion of members, locations of entrapped water/improper drainage, evidence of impact, condition of riprap, and/or indications of scour.
- Inspect wall for movement, rotation or settlement.
- Inspect crest of sloping backfill for evidence of soil stress or failure as an indication of settlement or wall movement.
- Inspect drainage facilities in the wall and in the proximity of the wall (above and below the wall) to ensure proper functioning of drainage.

2.15.4.1 MECHANICALLY STABILIZED EARTH WALL FIELD INSPECTION PROCEDURES

The critical factors affecting the long-term performance of MSE walls are: corrosion of the soil reinforcement, improper drainage, improper backfill material and compaction, freezing of entrapped water, and movement of the entire MSE Mass (global stability). Recommendations for inspection and maintenance of MSE retaining walls and their drainage systems are provided in IE 4.3.5.7.2.1I.

In some of the first generation MSE walls, there is a latent defect with the method of connection between soil reinforcement and precast facing panel. The soil reinforcement wires were attached to the panel using collets held in place by steel button heads welded to the end of the soil reinforcement (See Figure IP 2.15.4.1-1). The weld of the button head to the soil reinforcement has failed in some locations. The cold formed button head details were found to develop micro-cracks which contributed to the failure of the button head. The inventory inspection must determine from the shop drawings whether this type of connection was used. State whether or not the button head connection method was used in BMS2 item VW32.

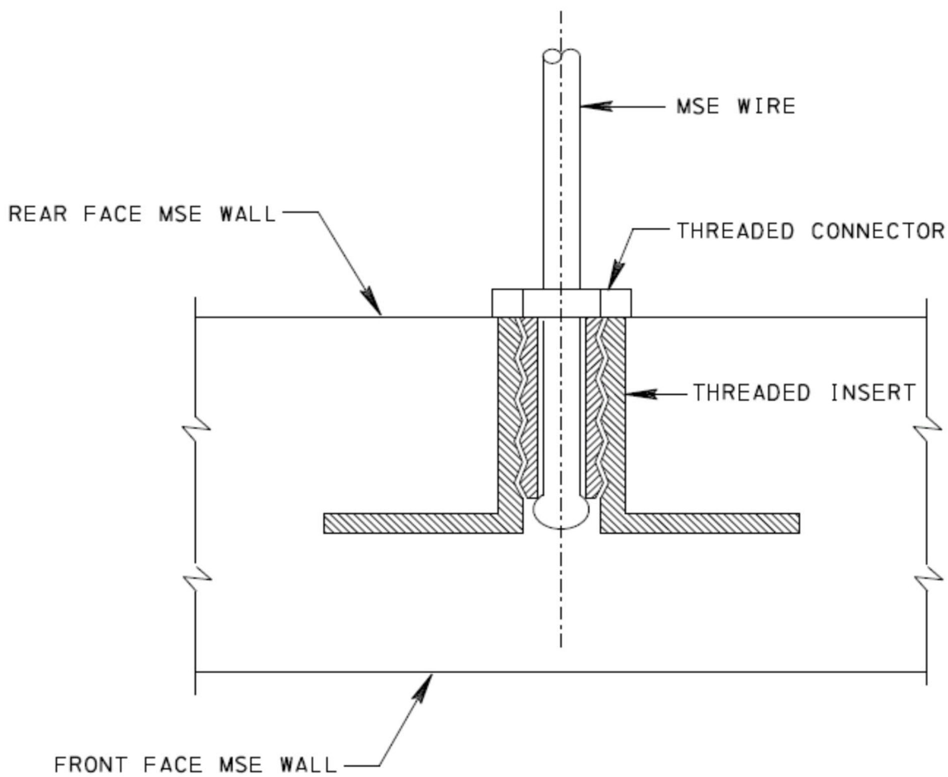

Figure IP 2.15.4.1-1

2.15.5 Determination of Maintenance Responsibility

Retaining walls which are inventoried in BMS2 and have a regular inspection schedule, shall be maintained by the owner as specified in BMS2. For retaining walls which are found in need of repair, but are not inventoried in BMS2, the following procedures shall be followed to determine who has the responsibility for maintenance.

PennDOT's guidelines have historically reflected that walls on the top side of a highway (which hold abutting property up) are the abutting land owner's responsibility, while walls on the bottom side (which hold the highway up) are PennDOT's responsibility. This should be considered a good first step in determining responsibility but is not totally supported by the law, as determining responsibility for walls along or within highway ROW requires case-by-case analysis. Ultimate responsibility depends on the location of the wall, who constructed it, its function, who has maintained it and other relevant matters.

The initial step in determining responsibility should begin with the District ROW unit to determine if the wall is within PennDOT limits. This may require additional coordination or assistance from the Bureau of Project Delivery's Right of Way and Utility Section. Once this is known, requests for determination of maintenance responsibilities of retaining walls should be made to the Deputy Chief Council of the Real Property Division. These requests shall include the following:

- Municipality in which the wall is located.
- All highway plans.
- Information about when and how the SR was taken over as a State Highway, if applicable.
- Confirmation/evidence of who constructed the wall.
- A statement on the function of the wall.
- Evidence of who, if anybody, has maintained the wall. This would include any District maintenance activity related to the wall and any evidence showing the local government or others have maintained the wall.
- Any indication of why the issue has arisen. Is the wall failing?
- Any other relevant facts.

If it is determined that the wall is PennDOT's responsibility, the repairs will need to be completed by PennDOT. The wall will also need to be inventoried in BMS2 and inspected on a regular cycle. If it is not PennDOT's responsibility, a letter shall be sent to the property owner as a notification of the issues that need to be addressed, following the format found in Publication 23 for encroachment. Since the OCC review process can take some time, documented communication with the property owner can begin before a final determination is made in order to make the property owner aware of the situation and see if any repairs are planned. Additionally, OCC has confirmed that inspecting the walls does not affect liability, and it is recommended to look into the safety of these walls to determine what needs to be repaired or addressed.

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3.1 GENERAL

Highway bridges shall be load rated in accordance with The AASHTO Manual for Bridge Evaluation (MBE), as supplemented by this Manual. Load Ratings shall consider the structural conditions, material properties, live loads, and traffic conditions at the bridge site.

Load Ratings shall be performed using either the LFR, ASR or LRFD method. LRFR ratings can be used on a case-by-case basis and must be approved by the Bridge Inspection Section Chief in advance.

3.2 LOADS

3.2.1 Dead Loads

The bridge analysis should include only those dead loads that the bridge currently carries. Typically, future dead loads such as future wearing surface used in design are not to be included in the analysis and rating for safety inspections. The analysis/rating from the design computations for a new or rehabbed bridge (including future loads) may be utilized for NBIS when the bridge conditions have not changed from design assumptions and the resulting conservative ratings are acceptable for posting and permit vehicles. However, when re-analysis of the bridge is required, only those current dead loads on the bridge are to be included.

Dead loads are to be fully documented in the analysis computations, including the listing of iron or steel shape properties and concrete, steel and/or other materials' weight computations. Member shapes not shown on plans shall be measured in the field and identified using steel shapes catalogs corresponding to the date of construction.

3.2.2 Live Loads

3.2.2.1 NBIS REQUIREMENTS

NBIS requires all states to load rate their highway bridges for two purposes:

- To provide a uniform measure of the live load capacity of the nation's bridges in the NBI for planning and programming purposes.
- To ensure bridges are properly posted for the legal load configurations used in individual States

1. **Live Load Rating for planning and programming purposes (NBI):** Historically, the AASHTO HS20 loading has served as the only live load needed for NBI planning purposes, primarily because it had been the design load for most bridges using either Load Factor Design (LFD) or Allowable Stress Design (ASD) methodologies. However, with the adoption of the Load and Resistance Factor Design (LRFD) method by AASHTO in 2000, the HL-93 is a better measure, especially for the LRFD bridges. In Pennsylvania, the PHL-93 loading has been accepted by FHWA as Pennsylvania's design vehicle.

   Because the number of LRFD bridges is still a limited portion of the in-service bridge inventory, FHWA has determined it was not cost-effective to require the re-rating of the ASD and LFD bridges for the new HL-93 live loading at this time.

2. **The State's legal load(s) for bridge load posting evaluations**: The legal load vehicles are used to determine the need to post weight restrictions on the bridge for public safety. Inventory and Operating level ratings are required for all legal load configurations (Pennsylvania Bridge Posting Vehicles). Note: For LFD and ASD ratings, the HS20 loading serves dual purposes for both planning and posting and should be designated as the NBI rating.

3.2.2.2 PA BRIDGE POSTING VEHICLES

The following vehicle configurations represent the legal load vehicles in PA and shall be used to establish the need for a bridge restriction under §4902(a) of the PA Vehicle Code. All highway bridges in PA, regardless of the analysis or rating method used, are to be rated for these bridge posting vehicles as part of the bridge safety inspection program. If the bridge's Safe Load Capacity (SLC) for any of the posting vehicles is less than their legal weight, the bridge is to be posted. SLC is discussed in IP 4.3.2. Posting Policy is discussed in IP 4.

- **AASHTO HS20 vehicle**

A. Vehicle Load Type
- Design vehicle.
- Standard lane load as per Figure M6B.6.2-2.

B. Vehicle Geometrics
- The axle weights and spacings are shown in Fig IP 3.2.2.2-1.
- For the HS20 truck width and transverse wheel location, see Figure M 6B.6.2-1.

C. Posting Considerations
- Can be used to determine weight restrictions applicable only to Combination Vehicles.
- Combination vehicles have a practical minimum weight of 10 tons. If the SLC for the H and HS vehicles is equal to or less than 10 tons, no separate posting sign for combination vehicles is warranted.

- **AASHTO H20 vehicle**

A. Vehicle Load Type
- Design vehicle.
- Standard lane load as per Figure M6B.6.2-2.

B. Vehicle Geometrics
- The axle weights and spacings are shown in Fig IP 3.2.2.2-1.
- Width of the H20 is the same as the HS20 truck.
- Transverse wheel location is the same as the HS20 truck.

C. Posting Considerations
- If the bridge's SLC for the H vehicle is 19 tons or greater, the posting shall be governed by the lesser of the ML80 SLC rating or the TK527 SLC rating.

- **ML80 vehicle**

A. Vehicle Load Type
- The ML80 loading is representative of the axle weights allowed by the Vehicle Code. It is not a notional load. All axles shall be considered when determining force effects.

B. Vehicle Geometrics
- The axle weights and spacings are shown in Fig IP 3.2.2.2-1.
- Width of the ML80 is the same as the HS20 truck.
- Transverse wheel location is the same as the HS20 truck.

C. Computing Live Load Effects
- When computing the ML80 Rating Factor (RF), use the axle spacings and weights for the posting vehicle shown in Figure IP 3.2.2.2-1.
- For the posting vehicle, 3% was added to the ML80 maximum registered weight to account for the tolerance allowed by the Vehicle Code for the portable scales used in truck weight enforcement efforts. The axle weights shown in Fig IP 3.2.2.2-1 have this scale tolerance included.

D. Determining ML80 rating (in Tons)
- Use the maximum registered weight of 73,280 lbs. (36.64 Tons) for the weight (W) of ML80 truck. The 3% scale tolerance used to compute the live load effect (L) is included only in computing RF.
- Substituting that maximum registered ML 80 weight:
  For ML80 RT = (RF)*W or RT = (RF)*(36.64).
- Use RT to determine the IR, OR and SLC for the bridge.

E. Special Considerations
- The practical minimum weight for ML80 trucks is 10 Tons. If the SLC for H and ML80 vehicles is equal to or less than 10 Tons, the posting shall be governed by the H rating.

- **TK527 vehicle**

A. Vehicle Load Type
- The TK527 loading is representative of the axle loads allowed by the Vehicle Code. It is not a notional load. All axles shall be considered when determining force effects.
- The TK527 vehicle represents a series of 5 to 7 axle trucks that were adopted as PA legal loads through Act 37 of 2001. The live load effects of various configurations and axle loadings were studied to determine a configuration to envelop the entire group. The seven-axle motor vehicle with a maximum gross weight of 80,000 lbs. produces moments and shears in excess of the five and six axle vehicles allowed under that law and was selected as the bridge posting vehicle to represent the series.

B. Vehicle Geometrics
- The axle weights and spacings are shown in Fig IP 3.2.2.2-1.
- Width of the TK527 is the same as the HS20 truck.
- Transverse wheel location is the same as the HS20 truck.

C. Computing the Live Load Effects
- When computing the TK527 Rating Factor (RF), use the axle spacings and weights for the posting vehicle shown in Figure IP 3.2.2.2-1.
- For the posting vehicle, 3% was added to the TK527 maximum registered weight to account for the tolerance allowed by the Vehicle Code for the portable scales used in truck weight enforcement efforts. The axle weights shown in Fig IP 3.2.2.2-1 have this scale tolerance included.

D. Determining the TK527 rating (in Tons)
- Use the maximum registered weight of 80,000 lbs. (40 Tons) for the weight (W) of the TK527 truck. The 3% scale tolerance used to compute the live load effect (L) is included only in computing RF.
- Substituting that maximum registered TK527 weight:
  For TK527 RT = (RF)W or RT = (RF)*(40).
- Use RT to determine the IR, OR and SLC for the bridge.

E. Posting considerations
- The practical minimum weight for TK527 trucks is 10 Tons. If the SLC for H and TK527 are equal to or less than 10 Tons, the posting shall be governed by the H rating.

COMPARISON OF LIVE LOAD EFFECT OF PA BRIDGE POSTING VEHICLES: For information only, a comparison of the bending moment effects of the bridge posting vehicles for various span lengths is illustrated in Figure IP 3.2.2.2-2. This figure is not an acceptable substitute for a rigorous analysis. The P82 Permit Load is shown for information only.

A table of simple span live load moments and shears for each of the posting vehicles for various span lengths are shown in Appendix IP 03-A.

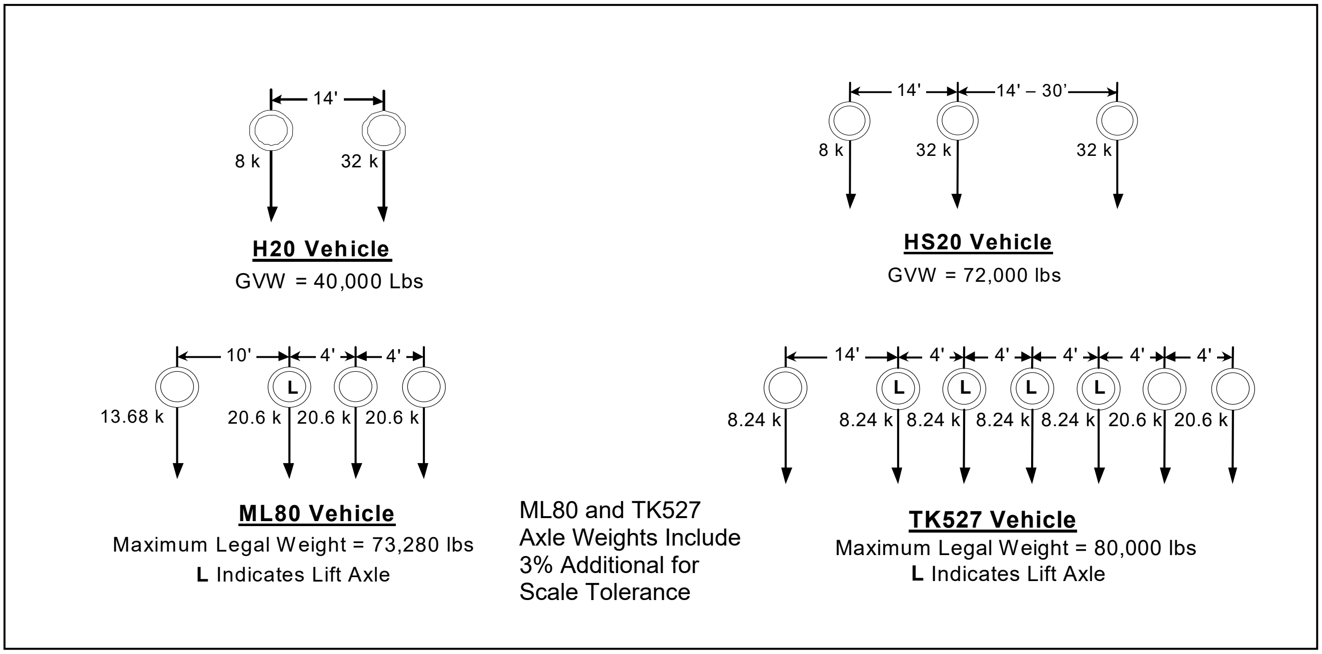

Figure IP 3.2.2.2-1 Bridge Posting Vehicles ─ Axle Configuration and Axle Weights

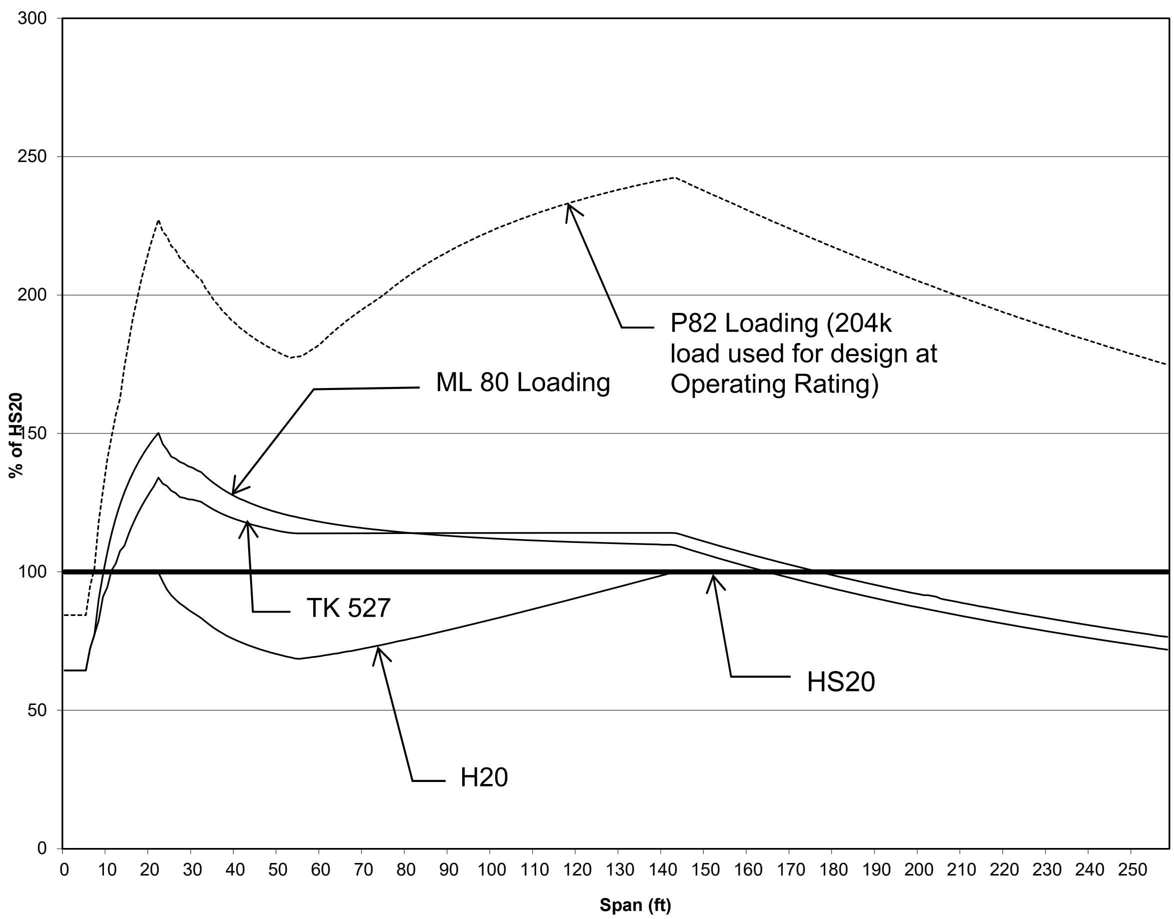

Figure IP 3.2.2.2-2 Comparison of Bridge Posting Vehicle Simple Span Bending Moments

3.2.2.3 AASHTO TYPICAL LEGAL LOADS

AASHTO identifies three typical legal loads that may be used for posting evaluations. These are the Type 3, Type 3S2 and Type 3-3 Vehicles. Because the live load effect produced by PA's posting vehicles is greater than the live load effects produced by these three AASHTO legal loads, the AASHTO legal loads are not used for rating or posting evaluations in PA. The axle weights and configurations for the three AASHTO legal loads are shown in Appendix M D6A.

3.2.2.4 AASHTO SPECIAL HAULING VEHICLES

FHWA Memorandum HIBT-10 dated November 2013 identified four AASHTO Special Hauling Vehicles (SHVs) that are to be included in rating and posting evaluations. These are the SU4, SU5, SU6, and SU7 vehicles. The department conducted a parametric study in 2016 that verified PA's posting vehicles envelope the SHVs for force effects and load posting. Therefore, the AASHTO SHVs are not used for rating or posting evaluations in PA. The axle weights and configurations for the four AASHTO SHVs are shown in Appendix M D6A.

3.2.2.5 FHWA FAST ACT EMERGENCY VEHICLES

FHWA Memorandum HIBS-1 dated November 2016 identified two Emergency Vehicles (EVs) that are to be included in rating and posting evaluations. These are the EV2 and EV3 vehicles. The EV2 and EV3 were developed by FHWA to encompass the effects of the family of emergency vehicles covered by the Fixing America's Surface Transportation (FAST) Act. The department conducted a parametric study in 2019 that verified PA's posting vehicles envelope the EVs for force effects and the specific conditions outlined for load posting. Therefore, the EVs are not required to be considered in posting evaluations in PA. Load rating evaluations for these vehicle types, however, shall be performed during the bridge's next rating update to be in compliance with FHWA's Memo HIBS-1. Atypical bridge decks (those less than 8" thick or with conditions affecting their capacity) shall also be evaluated for these vehicles. The axle weights and configurations for the two EVs are shown in the FHWA Memo HIBS-1.

3.2.3 Impact Loads

Impact loads shall be accounted for in the analysis and determined in accordance with AASHTO.

3.3 DISTRIBUTION OF LIVE LOADS ON LONGITUDINAL MEMBERS

Three methods are acceptable for distributing live load laterally to longitudinal members: Lever Rule, Simplified Line Girder, or Refined Analysis. Other methods of lateral live load distribution for longitudinal members must be approved by the Bridge Inspection Section Chief.

3.3.1 Lever Rule

The lever rule determines the portion of the live load distributed to a beam line by assuming the deck acts as a rigid beam and summing the moments of wheel loads about one support (beam line) to find the reaction at the other support (beam line). The lever rule is used to determine the live load lateral distribution to longitudinal members in the following situations:

1. To each girder or truss of a two or three-girder or two or three-truss bridge.
2. To exterior beams or stringers of beam-slab bridges.
3. To interior beams or stringers of beam-slab bridges with geometric properties that fall outside the range of applicability for using the Simplified Line Girder Method.

The lever rule can be used in other situations (box beams w/ S > 18', wood beams, steel grid deck on steel beams, etc.). See PD Table 4.6.2.2.2b-1 and PD Table 4.6.2.2.3a-1 for more information.

When the lever rule is used to distribute live load, a reduction in load intensity for multiple lanes of live load may be applied to truss or girder bridges with two main longitudinal members. See the appropriate sections of

AASHTO for LFD methodology (SD 3.12) or LRFD methodology (AD 3.6.1.1.2). The reduction factor for live load intensity may not be used on bridges with 3 or more girders in either methodology without the permission of the Bridge Inspection Section Chief.

3.3.2 Simplified Line Girder (AASHTO Distribution Factor)

3.3.2.1 GENERAL APPLICATION

The Simplified Line Girder is an empirical method used to distribute the vehicular live load laterally to the longitudinal girders. The Department allows either set of simplified line girder live load distribution factors that AASHTO developed for its two main design methodologies to be used for bridge analysis and rating:

- LFD Distribution Factors (or S-Over Factors) See IP 3.3.2.2.
- LRFD Distribution Factors See IP 3.3.2.3.

To use the AASHTO simplified line girder analysis distribution factors, the bridge must meet the specific applicability requirements in the appropriate AASHTO design specification and the following general constraints from AD 4.6.2.2.1 (as modified by PD 4.6.2.2.1):

- Deck width is constant.
- Four or more beams in the cross-section.
- Beams are reasonably parallel and have approximately the same stiffness (see IP 3.3.3.3).
- Roadway part of deck overhang does not exceed 3.0' from centerline of exterior beam.
- Structural members are not horizontally curved. (See as specified in AD 4.6.1.2.1 and PD 4.6.1.2.1).
- Skew angle is greater than 70 degrees (see IP 3.3.3.1).
- Cross-section is consistent with cross-sections shown in AD Table 4.6.2.2.1-1.

Exceptions to these general constraints are addressed in IP 3.3.2.3.

3.3.2.2 AASHTO LFD DISTRIBUTION FACTORS (S-OVER FACTORS)

The rules of applicability and formulas for the determination of the AASHTO LFD Distribution Factors (S-Over Factors) are outlined in SD 3.23.

A reduction in load intensity to account for multiple lanes of live load shall not be used in conjunction with the AASHTO LFD Distribution Factors. The reduction factors of SD 3.12 do not apply in this situation.

For pre-stressed or reinforced concrete adjacent box beam bridges, the live load distribution factors from SD 3.23.4 shall be replaced by the methodology of SD 3.23.4 from the 1983 AASHTO. This Section of the 1983 AASHTO is reproduced here in Figure IP 3.3.2.2-1 and is used in the Department's computer programs.

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3.23.4 Precast Concrete Beams Used in Multi-Beam Decks

3.23.4.1 A multi-beam bridge is constructed with precast reinforced or prestressed concrete beams that are placed side by side on the supports. The interaction between the beams is developed by continuous longitudinal shear keys and lateral bolts that may, or may not, be prestressed.

3.23.4.2 In calculating bending moments in multi-beam precast concrete bridges, conventional or prestressed, no longitudinal distribution of wheel load shall be assumed.

3.23.4.3 The live load bending moment for each section shall be determined by applying to the beam the fraction of a wheel load (both front and rear) determined by the following relations:

$$\text{Load Fraction} = S / D \qquad (3\text{-}11)$$

where

$$S = (12N_L + 9) / Ng \qquad (3\text{-}12)$$

$$D = 5 + N_L / 10 + (3 - 2\,N_L / 7)\,(1 - C / 3)^2 \quad \text{When} \quad C \leq 3 \qquad (3\text{-}13)$$

$$D = 5 + N_L / 10 \quad \text{When} \quad C > 3 \qquad (3\text{-}14)$$

N_L = total number of traffic lanes from Article 3.6
Ng = number of longitudinal beams
C = K(W / L), a stiffness parameter
W = overall width of bridge
L = span length in feet

VALUES OF K TO BE USED IN C = K (W / L)

Bridge Type	*Beam type and Deck Material*	*K*
Multi-beam	*Non-voided rectangular beams*	*0.7*
	Rectangular beams with circular voids	*0.8*
	Box section beams	*1.0*
	Channel beams	*2.2*

Figure IP 3.3.2.2-1 Live Load Distribution Factors for Prestressed Adjacent Box Beams

3.3.2.3 AASHTO LRFD DISTRIBUTION FACTORS

The rules of applicability and formulas for the determination of the AASHTO LRFD Distribution Factors are outlined in AD 4.6.2.2 and PD 4.6.2.2.

At the discretion of the rating engineer, the LRFD Distribution Factors may be used in LFD analysis and rating.

A reduction in load intensity to account for multiple lanes of live load shall not be used in conjunction with the AASHTO LRFD Distribution Factors. The multiple presence factors of AD 3.6.1.1.2 do not apply in this situation.

3.3.3 Bridges with Special Girder Geometry

A refined analysis may be required for bridges with girders that are skewed, curved, or variably spaced.

3.3.3.1 SKEWED BRIDGES

Skewed bridges are defined as structures having their highway centerline (or a parallel thereto) intersect a line parallel to the major axis of substructure units at an angle (θ) other than 90° (normal). For the definition of skew angle, refer to DM4 PP 3.2.2.

For bridges analyzed using the simplified girder analysis methodologies, the distribution of live load bending moment for skewed bridges is sufficiently in agreement with the AASHTO distribution factors developed for normal bridges and no adjustment is needed. However, the shear forces in a skewed bridge are attracted to the stiffer obtuse corner of the bridge and may significantly increase the vertical shear and girder reactions over the values calculated using the simplified girder distribution factors for normal bridges.

Shear skew adjustment factors for the simplified girder distribution factors are available to use on girders with skew angles less than 90º, but greater than 30º (see DM4 PD 4.6.2.2.3c). A more refined analysis is required for skewed bridges outside of the limits of applicability listed in DM4.

No skew adjustment factor for bending moment is required for ratings using simplified girder analysis or lever rule.

3.3.3.2 CURVED BRIDGES

Bridges with horizontally curved members meeting the requirements of AD 4.6.1.2 and PD 4.6.1.2 are to be analyzed using a refined method to accurately model actual conditions.

3.3.3.3 SPLAYED (VARIABLY SPACED) BEAM BRIDGES

In cases where straight beams are not parallel and the spacing varies along their length, the Live Load distribution to the beams, for non-refined analysis methods, is subject to interpretation. Generally, the average beam spacing or beam spacing at the centroid of contributing deck area, or some other weighted average may be used at the discretion of the rating engineer. See AD C4.6.2.2.1 for additional information. All assumptions made here are to be documented with the analysis. The beam spacing used shall be between the narrowest and the widest beam spacing present. A refined analysis may be warranted to accurately model actual conditions.

3.3.4 Refined Method of Analysis

The refined method of analysis for determining live load distributions on longitudinal members shall be done in accordance with AASHTO and PennDOT DM4. Programs used for this analysis method shall be Department approved (see IP 3.8).

3.4 DISTRIBUTION OF LIVE LOADS ON TRANSVERSE MEMBERS

If the bridge deck is directly supported by the transverse members only, the portion of the live load distributed to the transverse members is determined in accordance with SD 3.23.3.2 or AD 4.6.2.2.2f.

For transverse members not meeting the applicability requirements of the foregoing sections or for transverse members supporting a deck with longitudinal stringers, the Lever Rule or Refined Analysis should be used to distribute the live load.

Other methods of lateral live load distribution for transverse members must be approved by the Chief Bridge Engineer.

3.4.1 Lever Rule

The lever rule determines how the live load is distributed to a transverse member by assuming the deck acts as a rigid beam and summing the moments of wheel loads about one support (transverse member) to find the reaction at the other support (beam line). The lever rule is used to determine the live load lateral distribution to transverse members in the following situations:

1. Through stringers to end and interior floorbeams for deck floor systems with longitudinal members supported by floorbeams.
2. To interior and end floorbeams for deck floor systems with the deck supported directly by the floorbeams and with geometric properties that fall outside the range of applicability for using the Simplified Distribution Factors.

When the lever rule is used to distribute live load, a reduction in load intensity for multiple lanes of live load may be applied to the transverse members. See the appropriate sections of AASHTO for LFD methodology (SD 3.12) or LRFD methodology (AD 3.6.1.1.2).

3.4.2 Refined Method of Analysis

The refined method of analysis for determining live load distributions on transverse members shall be done in accordance with AASHTO and PennDOT DM4. Programs used for this analysis method shall be Department approved (see IP 3.8).

3.4.3 Distribution Factors for Transverse Members

3.4.3.1 GENERAL APPLICATION

The use of live load distribution factors for transverse members is applicable only in bridge decks that are directly supported by floorbeams only (no stringers in the deck system).

Distribution Factors are an empirical method that uses an estimation of the relative stiffness of the deck to the floorbeams to distribute the vehicular live load distribution laterally to the transverse members. The Department allows either set of live load distribution factors that AASHTO developed for its two main design methodologies to be used for bridge analysis and rating:

- LFD Distribution Factors See IP 3.4.3.2.
- LRFD Distribution Factors See IP 3.4.3.3.

The live load distribution on transverse members not meeting the applicability requirements for using LFD or LRFD Distribution Factors shall be determined using the Lever Rule or by a Refined Analysis.

3.4.3.2 AASHTO LFD DISTRIBUTION FACTORS (S OVER FACTORS)

The rules of applicability and formulas for the determination of the AASHTO LFD Distribution Factors (S-Over Factors) are outlined in SD 3.23.

A reduction in load intensity to account for multiple lanes of live load shall not be used in conjunction with the AASHTO LFD Distribution Factors. The reduction factors of SD 3.12 do not apply in this situation.

3.4.3.3 AASHTO LRFD DISTRIBUTION FACTORS

The rules of applicability and formulas for the determination of the AASHTO LRFD Distribution Factors are outlined in AD 4.6.2.2.2f. At the discretion of the rating engineer, the LRFD Distribution Factors may be used in an LFD analysis and rating.

A reduction in load intensity to account for multiple lanes of live load shall not be used in conjunction with the AASHTO LRFD Distribution Factors. The multiple presence of live load factors of AD 3.6.1.1.2 do not apply in this situation.

3.4.4 Guidance for Closely Spaced Floorbeams

For determining the moment and shear in interior floorbeams spaced between 9.5’ and 15.5’, the lane load will control the HS loading. This lane load is to be applied as the distributed load (640 lbs. per linear foot of load lane) plus a concentrated load (26,000 lbs.). In this case, the 26 kip concentrated load normally used for checking shear on longitudinal beams is to be applied to calculate HS live load moment and shear for the transverse beam. The BAR7 Program uses this procedure to determine the applied forces on floorbeams.

3.4.5 Cross Girders

Cross girders (or cross tie girders) are transverse members that span from one column or substructure unit to another and transfer the superstructure loads from several girders to the substructure. Cross girders are used where the use of traditional wall piers or multi-column bents would otherwise obstruct highways or railroads beneath the structure. Typically, cross girders are steel members, although some pre/post tensioned concrete members have been used.

Although cross girders are considered to be part of the substructure, they function in a similar manner as floor beams on trusses and are to be considered as main members carrying live load. Cross girders are to be load rated using the bridge posting vehicles. Live load and dynamic load allowance/impact shall be calculated in the same manner as it is for transverse floorbeams. If the safe load capacity of the cross girder is not sufficient to safely carry the legal loads, the bridge is to be posted for a weight restriction. Because they are fracture critical, cross girders should be inspected carefully.

3.5 ANALYSIS OF MULTI-SPAN PRESTRESSED CONCRETE BEAM BRIDGES

For multi-span prestressed concrete girder bridges without a deck joint over a pier, the details of the beams and deck reinforcement must be reviewed to determine the ability of the superstructure to act in a continuous manner for those spans. The rating engineer must carefully review the original design computations and design/shop drawings to ascertain the level of continuity that the structure can achieve. If full continuity for superimposed dead loads and live loads cannot be realized because reinforcement area or details are inadequate, the bridge should be analyzed as a series of simply supported spans.

3.6 LIVE LOAD CAPACITY RATING METHODS

3.6.1 Live Load Rating Methods for Bridge Posting Evaluations

The following methods are acceptable, within the applicability limits of AASHTO and this Manual, to determine the live load capacity of bridges:

- Allowable Stress Method
- Load Factor Method
- Load and Resistance Factor Rating Method (LRFR)
- Load and Resistance Factor Design Method (LRFD)
- Engineering Judgment
- Load Testing (use of this method requires prior approval of the Bridge Inspection Section Chief)
- Assigned Ratings

The rating engineer may select the most appropriate of the approved rating methods for the posting evaluation. LRFR ratings can be used on a case-by-case basis and must be approved by the Bridge Inspection Section Chief in advance. Other rating methods (not listed above) must also be approved by the Bridge Inspection Section Chief.

For the rating of a single bridge component, one method shall be used to determine the live load capacity for all of the bridge posting vehicles. More than one method of rating may be used on a bridge to evaluate different components (example: ASD would be used for truss members while the rating engineer may elect to use LFD for the floor system.)

The ratings of the various bridge posting vehicles used for the bridge posting evaluations are to be entered in the appropriate subfields in BMS2 Items IR10 Inventory Rating and IR11 Operating Ratings. See the BMS2 Coding Manual (Pub 100A) for more detailed instructions. The rating method used for the controlling member's posting evaluation is to be recorded in BMS2 Item IR06.

3.6.1.1 ENGINEERING JUDGMENT

Engineering judgment alone shall not be used to determine the live load capacity of a bridge component where sufficient structural information is known.

A bridge rating based upon engineering judgment should consider, but is not limited to, the following, factors:

- Condition of the load carrying components
- Material properties of members
- Redundancy of load path
- Traffic characteristics
  - Number and size of trucks
  - Loading
  - Projected traffic
- Performance of bridge under current traffic
  - Evidence of distress
  - Evidence of excessive movement under load
- Bridge restrictions (Past, current, and proposed)

When using engineering judgment for the main live-load carrying members/components, ratings are to be determined for all of the bridge posting vehicles at the Inventory and Operating Rating levels for the live load carrying component of the bridge. These vehicle ratings are needed for the posting evaluation.

One reasonable approach to determine the ratings for the various vehicles is:

1. Establish the Safe Load Capacity for the posting vehicle that represents the most critical loading (shear or moment).
2. Multiply the critical vehicle's rating factor for SLC by the ratio of the live load effect of the critical vehicle to the live load effect of the other posting vehicle. For example, if the ML80 is the critical posting vehicle, to determine the HS rating from the bending moment live load effect:
   Rating Factor for SLC_{HS} *= Rating Factor for* SLC_{ML80} ** (*$LLM_{ML8}0/LLM_{HS}$*)*
   where LLM = Live Load Moment and $SLC_{HS} = RF \times W$
3. To determine the OR and IR from the SLC for each vehicle, use appropriate ratios as determined by the engineer. Suggested ratios are as follows:
   $OR = SLC * 1/\ f$

   $IR = 60\% * OR$
   where f = Safe Load Capacity Reduction Factor (see IP 4.3.2)

For bridges posted for weight restrictions based solely on the condition of components other than the main load carrying members, the restrictions may be less than the Inventory Ratings, but not greater than the Safe Load Capacity for the main load carrying members (see IP 4.4.4).

BRIDGES WITHOUT PLANS: In PA, the vast majority of bridges either have sufficient design drawings or the properties of the members can be verified through field measurements to support an engineering analysis. However, for many older concrete or masonry structures (including slabs, beams, and arches), the structural components either cannot be measured (arches) or critical details (e.g., reinforcement details) are not known with sufficient confidence to evaluate through computations. For these structures, a rating based on engineering judgment by a qualified engineer familiar with the bridge and the factors listed above may be appropriate. A suggested method for applying engineering judgment alone to determine the ratings of such bridges without plans is contained in Appendix IP 03-B.

3.6.1.2 ASSIGNED LOAD RATINGS

In accordance with FHWA's Assigned Load Ratings Memo dated September 29, 2011, certain bridges currently in service with benign condition deterioration, designed and checked by modern methods for modern bridge loadings, and with no changes to dead loads and State legal and routine permit vehicular loads since the design was completed may adequately have their load carrying capacity calculated. A separate analysis would not be required. FHWA has determined that inventory and operating ratings may be assigned based on the design loading, provided the following conditions are met:

1. The bridge was designed and checked using either the AASHTO Load and Resistance Factor Design (LRFD) or Load Factor Design (LFD) methods to at least PHL-93 or HS-20 live loads, respectively; and
2. The bridge was built in accordance with the design plans or shop drawings; and
3. No changes to the loading or structure condition have occurred that could reduce the inventory rating below the design load; and
4. An evaluation has been completed and documented, determining that the force effects from State legal loads or permit loads do not exceed those from the design load (this will be true for all bridges designed by PennDOT standards for the PHL-93 vehicle); and
5. The checked design calculations and relevant computer input/output information must be accessible and referenced or included in the individual bridge records.

A summary of the assigned load rating, which demonstrates these five conditions are met, is to be included in the bridge file and approved by the individual charged with the overall responsibility for load rating bridges (Assistant District Bridge Engineer-Inspection), or by an individual meeting 23 CFR 650.309(c) qualifications and delegated, in writing, this approval authority. If any of these conditions cannot be met for a bridge at any point during its service life, load ratings cannot be assigned and must be determined by other methods defined in IP 3.6.1.

If complete design files have not been retained for existing bridges, design plans that clearly identify the loading as at least PHL-93 or HS-20 and bear the stamp of a licensed professional engineer may be used by the individual responsible for load rating under 23 CFR 650.309(c) as the basis for an assigned load rating. The approval needs to be documented as the basis for the assigned rating and become part of the official bridge records. This information demonstrates satisfaction of conditions (1) and (5) above. Conditions (2), (3), and (4) still need to be met.

For state bridges designed using LRFD, load ratings based upon LF or LRFD methodology must be performed for APRAS purposes.

3.6.2 Live Load Capacity Rating for the NBI

FHWA requires that live load capacity ratings are to be performed for either the HS20 or the HL-93/PHL-93 loadings. BMS2 Item IR05 is used to designate which live load vehicle is reported to FHWA in the annual NBI report. The NBI load ratings at both IR and OR rating levels are to be reported in BMS Items IR10 and IR11 for tons and IR20 and IR21 for rating factors. Accordingly, for the NBI rating (IR05 = 1), provide the rating for the appropriate combination of design methodology and live loading configuration as shown in Table IP 3.6.2-1.

Table IP 3.6.2-1 below summarizes the above requirements for the live load configuration for the NBI rating.

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<table>
<tr><th colspan="5">Table IP 3.6.2-1 Live Load Configuration to be Used for NBI Rating</th></tr>
<tr><th>Design Method For Superstructure</th><th>Bridge Placed in Service</th><th>Rating Purpose</th><th>NBI Rating</th><th>Rating Method</th></tr>
<tr><td rowspan="6">LRFD</td><td rowspan="3">On or After 2011</td><td>Design rating or reconstruction</td><td>PHL-93 (Rating Factors)</td><td>LRFD</td></tr>
<tr><td>Re-rating due to loading or structure condition change</td><td>PHL-93 (Rating Factors)</td><td>LRFD or LRFR</td></tr>
<tr><td>Design Rating for Superstructure Replacement</td><td>PHL-93 (Rating Factors)</td><td>LRFD</td></tr>
<tr><td rowspan="3">Before 2011</td><td>Design rating</td><td>PHL-93 (Rating Factors) or HS20 (Tons)</td><td>LRFD or LFD</td></tr>
<tr><td>Re-rating due to loading or structure condition change</td><td>PHL-93 (Rating Factors) or HS20 (Tons)</td><td>LFR, LRFD, or LRFR</td></tr>
<tr><td>Design Rating for Superstructure Replacement</td><td>PHL-93 (Rating Factors) or HS20 (Tons)</td><td>LRFD</td></tr>
<tr><td>ASD, LFD, or Other</td><td>Any time</td><td>Design rating or Re-rating</td><td>HS 20 (Tons)</td><td>LFR or ASR</td></tr>
</table>

3.6.3 Allowable Concrete Tensile Stresses for Prestressed Concrete Beams

It has been Department policy to limit the design tensile stresses in concrete of the beam to a maximum value of $3\sqrt{f'c}$ to avoid potential long-term problems related to fatigue of the strands. This same value should be used for bridge ratings using the LFR method.

However, if the ratings using $3\sqrt{f'c}$ would necessitate a bridge weight restriction, the allowable concrete tension may be raised to a value of $6\sqrt{f'c}$ if a fatigue check of the beams results in adequate remaining fatigue life.

3.7 MATERIAL TESTING, STRENGTH OF MATERIALS, AND INSTRUMENTATION FOR ANALYSIS

3.7.1 Non-Destructive Testing

Non-Destructive Testing (NDT) is a critical part of bridge inspection and evaluation. NDT is used to supplement the visual inspection by providing information regarding the condition of bridge components that is not detectable by a visual inspection alone. NDT is a generic name given to repeatable processes applied to components or structures to determine the condition of the structure's material without compromising structural integrity. To ensure accurate NDT results and resulting programming decisions, properly trained individuals should carefully perform the tests. The various NDT methods and their capabilities for detecting defects in different materials are discussed in M 5.2.

3.7.2 Strength of Materials

The strength of materials for analysis shall be determined using the following hierarchy:

- From the as-built plans.
- From the design plans.
- From specifications at the time the structure was built.

If the material strength/properties are still not known with confidence, the material strengths for steel, concrete and timber may be determined from tables and/or testing (see IP 3.7.2.1, IP 3.7.2.2, and IP 3.7.2.3).

3.7.2.1 STEEL MATERIAL PROPERTIES

The material properties of steel may be determined using the "Date-Built" tables in M6B.5.2.1. If further information or confidence in the material properties is required, the steel may be tested in accordance with M5.3 through M5.6. Material samples removed from the structure shall be documented and removal performed so that the structural integrity of the bridge or its components is not compromised.

3.7.2.2 CONCRETE MATERIAL PROPERTIES

If the original specifications for a bridge are not available, the material properties of concrete may be assumed from the values in Table IP 3.7.2.2-1. If further information or confidence in the material properties is required, the concrete may be tested in accordance with M5.3 through M5.6. Material samples removed from the structure shall be documented and removal performed so that the structural integrity of the bridge or its components is not compromised.

Table IP 3.7.2.2-1 Specified Concrete Strengths for Department Bridges

Date Range	28-Day Design Strength (psi)				Deck Slab Concrete Strength (psi)		
	Class AAA	Class AA	Class A	Class B	Design Strength	Design (fc)	28 Day (f'c)
1990-Current	4500	3500	3000		4000		4500
1984-1989	4500	3500	3000		4000		4500
1968-1983	4500	3500	3000		4500		4500
1963-1967		3500	3000	2500	3500	1000	3500
1950-1962		3000	3000	2500	3000	1000	3000
1949 & Earlier			3000	2200	3000	1000	3000

3.7.2.3 TIMBER MATERIAL PROPERTIES

The material properties of timber are to be determined in accordance with SD Chapter 13 and M 6B.5.2.7 or through testing in accordance with M 5.3 through M 5.6.

3.7.3 Instrumentation

Instrumentation of a bridge may be necessary if the structure cannot be accurately modeled by analysis, the structural response to live load is in question, or as a last means to avoid a weight restriction on a significant structure. Non-destructive load testing shall be in accordance with IE 08.

3.8 BRIDGE RATING SOFTWARE

Use Department developed or Department approved software for the live load rating of bridges. See DM4, PP 1.4.7 for a list of PennDOT LRFD and LFD engineering programs. See Accepted Commercially Available or Consultant Developed Software on PennDOT's website:
http://www.dot.state.pa.us/public/Bureaus/BOPD/Bridge/Accepted-Software/BDTD-Accepted-Software.pdf

3.9 LOAD RATING APPROVAL AND DOCUMENTATION

Analyzing and load rating bridges based on the most current field conditions is an essential component to ensure public safety. The results of the load rating analysis are used to determine whether or not a bridge is able to support legal loads. Due to the criticality of this matter, all load ratings are to be sealed and signed by a registered Professional Engineer (P.E.) in Pennsylvania. For a load rating analysis performed by Department personnel, the District Bridge Engineer or the Assistant District Bridge Engineer for Inspection is to sign and seal the load rating analysis.

Proper documentation of the load rating analysis assists in the review of the load rating and facilitates future load ratings, if required. An integral part of the load rating is a load rating summary page which summarizes the results of the load rating, rating method and assumptions. All load rating analysis shall have a load rating summary page as part of the bridge file. The load rating summary information shall be referenced by inspectors during inspections to identify conditions that are different than accounted for in the load rating analysis. See IP 8.3.2 for proper load rating analysis documentation. A sample load rating summary form is in Appendix IP 03-C.

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4.1 GENERAL COMMENTS ON BRIDGE RESTRICTIONS

Size and weight restrictions on vehicles are sometimes necessary to ensure public safety and to safeguard our bridge infrastructure. Because bridges are a critical link for transportation in PA, bridge restrictions must be prudently established to maintain an adequate level of safety without unduly restricting the movement of goods and services (especially emergency services).

There are three basic types of restrictions placed on vehicles crossing over or under bridges:

- Weight restrictions based upon the condition of the bridge.
- Weight restrictions based upon traffic conditions.
- Vertical clearance restrictions.

The needs for these restrictions are ascertained through the bridge safety inspection program. Every effort must be made to minimize both additional restrictions and their resultant economic impact without compromising either public safety or full compliance with NBIS/NTIS. It is the responsibility of the District Bridge Engineer or the bridge owner to ensure that proper bridge restriction signs are installed and maintained for this critical public safety need.

4.2 STATUTES AND REGULATIONS REGARDING BRIDGE RESTRICTIONS

The below listed statutes and regulations are important to the issues of bridge restrictions.

- **NBIS (National Bridge Inspection Standards)**
  §650.313 of this federal regulation requires that bridges are to be load rated and if the state legal loads exceed the loads allowed under the Operating Rating, the bridge must be posted for a restriction. (A copy of the NBIS is in Appendix IP 01-B.)

- **PA Statute Act 44 of 1988**
  Act 44 amended the PA Administrative Code of 1929 to enlarge the powers and duties of the Department. In part, Act 44 established the Department's responsibilities for the safe posting of locally owned bridges. Act 44 authorizes and requires the Department to inspect (which includes load rating) and post locally owned NBIS bridges as needed. See IP 1.6.3 for further information on Act 44.

- **TITLE 75 VEHICLES (PA Vehicle Code)**
  Chapter 49 Size, Weight and Load authorizes the Department and local bridge owners to place restrictions on the vehicles using bridges and highways. Two subsections are pertinent to establishing these bridge weight or size restrictions:
  - § 4902(a) Restrictions based upon the condition of the bridge.
  - § 4902(b) Restrictions based upon traffic conditions.

- **TITLE 67 TRANSPORTATION**
  Title 67 sets Department regulations governing transportation issues. Chapters relevant to load posting of bridges include:
  - Chapter 191 Authorization to Use Bridges Posted Due to Condition of Bridge.
  - Chapter 212 Official Traffic-Control Devices.

  An Internet version of TITLE 67 can be found at the website http://www.pacode.com/.

- **NTIS (National Tunnel Inspection Standards)**

§650.513 of the NTIS federal regulation requires that tunnels are to be load rated and if the state legal loads exceed the loads allowed under the Operating Rating, the tunnel must be posted for a restriction. (A copy of the NTIS is in Appendix IP 01-C.)

4.3 BRIDGE POSTING EVALUATIONS

4.3.1 Requirements for Bridge Posting Evaluations

Each highway bridge is to be evaluated for its ability to safely carry each of the bridge posting vehicles as part of each bridge safety inspection. This posting evaluation is performed once the current bridge conditions are known and the Inventory Ratings (IRs) and Operating Ratings (ORs) for each of the posting vehicles have been determined (or verified from previous inspections). Any bridge that cannot carry the posting vehicles at its safe load capacity must be posted for the appropriate bridge restriction. See IP 3.2.2 for a description of the bridge posting vehicles that represent the various PA legal load configurations.

The posting evaluation must include a recommendation about the need for a bridge restriction that would be governed under **PA Vehicle Code § 4902(a) Restrictions based on the condition of the bridge.** Recommended bridge restrictions may consist of a posted bridge weight limit, a "One Truck at a Time" restriction, or a combination of both. Closure of a bridge is considered to be the most severe weight posting. In special circumstances, other vehicle restrictions may be imposed.

The bridge posting evaluation is the justification for imposing a § 4902(a) restriction and is to be maintained as a part of the permanent bridge record. A licensed professional engineer must prepare the bridge posting evaluation.

If a new restriction or a revision to a previous restriction is needed, the posting evaluation must be sufficiently detailed to fulfill the requirements of TITLE 67 Chapter 212 Official Traffic-Control Devices. Generally, the bridge posting evaluation focuses on the information in the §212 Appendix, item 2 (18), Structural analysis, but other factors pertinent to the load posting (e.g., ADT, ADTT) are to be added as appropriate.

4.3.1.1 ELEMENTS OF A BRIDGE POSTING EVALUATION:

1. Summary recommendation addressing the need for a bridge restriction based on its condition
   a. If a weight restriction is not needed, state it as so.
      EXAMPLE:
      The Safe Load Capacity (SLC) of the bridge is greater than the live load effects of the bridge posting vehicles and there is no need for a bridge weight restriction under §4902(a) of the PA Vehicle Code.

   b. If a new restriction or revision to an existing restriction is needed:
      - State proposed restriction(s)

        EXAMPLE (for format only):
        – *The following restrictions are to be placed on the bridge under §4902(a) of the PA Vehicle Code:*
          Bridge Weight Limit 25 Tons Except Combinations 32 Tons
          And Bridge Limited To One Truck At A Time

      - State reason(s) for the restriction
        NOTE: This reason is intended to succinctly inform the owner and public of the critical safety need for the bridge restriction. Accordingly, this section should not be a detailed description of bridge conditions and ratings. It should be simple and direct language similar to the reasons listed in BMS2 Item VP06 Reason for Posting/Closing the Bridge.

        EXAMPLES OF REASONS FOR RESTRICTION:
        – *This bridge restriction is necessary because the main bridge members (floor beams) are deficient and cannot carry the legal loads safely.*

        – *This bridge restriction is necessary because the main bridge members (girders) are deficient and cannot carry legal loads safely.*

2. Summary of bridge ratings for each bridge posting vehicle.
    a. List IR, OR, and SLC for each posting vehicle and appropriate load effects (e.g., moment, shear, axial compression) for controlling superstructure member(s). This is generally done in table format. If “One Truck At A Time” restriction is proposed, list ratings for both normal traffic and for “One Truck” loading.
    b. Identify controlling member(s). Note if member is non-redundant and identify section and/or page number of bridge analysis and rating computations for reference.
    c. Provide additional information for special conditions:
        - If the capacity of the bridge is limited by the condition an element not considered in the superstructure analysis (e.g., deck, pier cap), provide additional IR/OR/SLC for that portion of the structure with justification and/or supporting computations.
        - If “One Truck at a Time” restriction is proposed, provide additional information as required by IP 4.4.3 to demonstrate that site conditions are appropriate for that kind ofrestriction.
        - If the bridge is being restricted as the result of a PUC Order, include the basis for the order (e.g., bridge analysis and rating by the Department) and a copy of the Order.

Identify the date of inspection for which the bridge conditions used in the rating were developed. If the conditions and bridge ratings have not changed since the previous posting evaluation, state it as so.

4.3.2 Safe Load Capacity for Bridges

The rating engineer must determine the Safe Load Capacity (SLC) for each of the bridge posting vehicles at the controlling sections/members of the bridge for the various load effects (such as moment, shear, axial compression, etc.). The SLC may be determined by engineering calculations or procedures or by engineering judgment. Bridge restrictions should be based upon the SLC.

It should be understood that the SLC is not a single number and may involve different members or sections for each of the load effects and the various live load configurations. However, for simplicity in this article, the SLC will be discussed as if it were a single value.

SLC AND OPERATING RATING: By definition (M 6.3.2), the maximum SLC for a bridge cannot exceed its Operating Rating (OR). The SLC is determined by modifying the OR by using the Safe Load Capacity Reduction Factor, which accounts for the condition of the bridge as shown in the equation below.

$$SLC = f * OR$$

Where: f is the Safe Load Capacity Reduction Factor.

A Safe Load Capacity Reduction Factor less than 1.0 should be used when the substructure or superstructure has a condition rating of 4 or less, as shown in Table IP 4.3.2-1. When determining the SLC for H vehicle, f should not be less than 1.0.

Table IP 4.3.2-1: Safe Load Capacity Reduction Factors

ADTT > 500	Superstructure or Substructure		
Condition Rating	> 5	4	< 3
f	1.0	0.80	0.80

ADTT < 500	Superstructure or Substructure		
Condition Rating	≥ 5	4	≤ 3
f	1.0	0.90	0.80

Aside from the establishing the reductions due to the condition ratings, the owner or District may elect to establish a particular Safe Load Capacity Reduction Factor for various reasons, including: probability of overloads, degree of load path redundancy, presence of fracture-prone details, etc. For Department bridges other than those with a Condition Rating of 4 or less, the posting evaluation must include justification for a SLC less than 100% of the OR.

SLC AND INVENTORY RATING: Because the Inventory Rating (IR) of a bridge represents a live load that can safely utilize an existing structure for an indefinite period of time (by definition M 6B.2.1), the SLC of a bridge must be equal to or greater than its IR at the section being evaluated. When the SLC is based upon the structural rating, a bridge cannot be restricted under § 4902(a) of the Vehicle Code at a level less than its IR (see TITLE 67 §212 Appendix). However, the SLC and restriction may be limited by the poor condition of other components (see IP 4.4.4).

4.4 WEIGHT RESTRICTIONS BASED UPON THE CONDITION OF THE BRIDGE

Weight restrictions based on the condition of the bridge are subject to enforcement under § 4902(a) of the Vehicle Code.

4.4.1 Bridge Restrictions – Types of Weight Postings

In PA, the weight restrictions on bridges and highways are established for two basic types of postings:

- **All vehicles**
- **All vehicles except Combination vehicles**
  - Combination vehicles are more commonly known as semi-tractor trailers.
  - This posting is generally higher than postings for H20, ML80, and TK527 because of the better distribution of loads in the HS vehicle.

For bridges restricted under § 4902(a) based on the condition, the bridge weight restriction for each of these two basic types of postings is established using the following rating vehicles:

- **All vehicles**
  - Bridge posting vehicles: H20, ML80, TK527, and HS20 (see IP 3.2.2).
- **Combination vehicles:**
  - Represented by the bridge posting vehicle HS20.

4.4.2 Bridge Restrictions – Vehicle Weight Limit

Weight restrictions for vehicles using the bridges shall be established within the following limits:

- **Postings for all vehicles**
  - Using the controlling load case from the following bridge posting vehicles: H20, ML80, TK527, and HS20.
  - Minimum Posted Weight Limit: 3 Tons.
  - Maximum Posted Weight Limit: 36 Tons if ML80 vehicle controls.
  - Maximum Posted Weight Limit: 40 Tons if TK527 vehicle controls and ML80 rating is greater than 36 Tons.

- **Postings for Combination vehicles using the "Except Combinations" posting sign:**
  - Using the bridge posting vehicle HS20.
  - Minimum Posted Weight Limit: 10 Tons (practical minimum weight of Combination vehicle).
  - Maximum Posted Weight Limit: 40 Tons (for Rating ≥ 36 Tons).
  - For example: ML-80 Rating = 33 Tons, HS20 Rating = 37 Tons: Post "33 Tons Except Combinations 40 Tons"
  - Reason: The lighter HS20 force effect envelopes the other legal combination vehicles that go up to 40 Tons. If the posting for combinations were set at 37 Tons, it would unnecessarily restrict legal vehicles which weigh up to 40 Tons.

- **Lowest Legal posting**
  - The lowest legal posting is 3 tons (H rating). If a bridge cannot safely sustain the minimum 3 Ton posting, the bridge must be closed.

- **Other considerations for weight postings**
  - **Weight limit values on signs** The MUTCD allows the posting signs (R12-1 and R12-5A) to present the weight limit in pounds or in tons (including fractions of tons). For example, a 12 ½ ton weight limit sign is legal and enforceable. However, the Department recommends that the weight limits be established only in integer values of tons because:

- The fractions of tons may be harder to read and the possibility that the truck driver may misread the sign is real and a threat to public safety.
- The fractional tonnage implies a level of precision in the bridge capacity determination and in the actual vehicle weight that may not exist.

– **Weight limits established by engineering judgment** When performing a bridge posting evaluation using engineering judgment (without an analysis), the precision of the bridge's live load capacity (IR, OR, and SLC) does not support a fractional tonnage value for the weight restriction signs. The use of 5-ton increments in the weight restrictions is recommended for "engineering judgment" postings, especially for higher weight limits.

– **Special vehicles** When a bridge posting evaluation may result in low weight restrictions, the need for special vehicles such as school busses and ambulances to use the bridge on a relatively low frequency should be considered. Although the weights of the actual vehicles are the best level of information for the rating, a typical school bus is approximately the same as a 17 Ton H truck and a typical box-type ambulance is about a 6 Ton H vehicle.

4.4.3 Bridge Restrictions – One Truck at a Time

Bridges are analyzed and rated for the general live load consideration that the traffic is not controlled and there will be more than one truck on a bridge at time. If the bridge's SLC for the multi-presence of live load case is less than Operating Rating for the bridge posting vehicles, the need for a vehicle weight restriction can be avoided or minimized if the District Traffic Engineer can demonstrate that the loading case of only a single vehicle on the bridge is appropriate for the site.

Traffic characteristics, site conditions, and the bridge configuration must be considered to warrant the use of the "One Truck" restriction. If it has been determined that the "One Truck At A Time" restriction is appropriate for the site and that the required signing will be installed, the SLC for the bridge may be analyzed and rated for each posting vehicle on the assumption that only a single vehicle will be on the bridge. The "One Truck" bridge restriction may be used alone or in conjunction with posted weight limits.

A bridge is a candidate for the application of a "One Truck At A Time" restriction if the following conditions are met:

1. The bridge roadway width is eighteen (18) feet or less (limiting it to one directional traffic), Or
2. The probability of having two fully loaded trucks on the bridge at the same time is minimal because all the following criteria are met:
    a. The total length of the structure does not exceed two hundred (200) feet unless a traffic study determines that the 200 feet limitation can be safely exceeded.
    b. The Average Daily Truck Traffic (ADTT) does not exceed 200, unless a traffic study including a truck classification count indicates that the truck traffic limit of 200 can be safely exceeded.
    c. There is adequate sight distance in both directions to provide the necessary driver reaction time.
    d. There is adequate space to stop the approaching vehicle safely.
    e. Advanced signing can be properly placed.

Information to demonstrate that the above conditions are met for the use of the "One Truck At A Time" is to be included in the posting evaluation. The District Traffic Engineer is to sign Page 4 of the Bridge Load Posting Recommendation Form (see Appendix IP 04-A) verifying that the conditions of Item 2 above are satisfied.

4.4.4 Bridge Restrictions Based Upon the Condition of Other Components

Typically, only the main live load-carrying superstructure members are analyzed and rated to determine the need for a bridge restriction. However, when the engineer has determined that the condition and/or structural makeup of other bridge elements, including, but not limited to, the deck, pier cap, arch spandrel walls, cross-frames and diaphragms, substructure units, etc. have compromised the bridge's safety to carry live loads, the bridge restriction should be based on the controlling component.

For bridges posted for weight restrictions based solely on the condition of components other than the main live load carrying members, the restrictions may be less than the IRs, but not greater than the SLC for the main live load carrying members. The reason for such postings must be clearly identified in the posting evaluation and BMS2 Item VP06 (see IP 3.6.1.1) The posting evaluation is to identify the IR, OR, and SLC for the main live load carrying members.

4.4.5 Bridge Restrictions – Exemptions for Certain Vehicles

- **Use of "Except Local Deliveries" Sign for Bridges Restricted due to Condition**
  While V.C. §4902(a) allows the owner to exempt certain vehicles (e.g., School busses, emergency vehicles…) from the posted weight restrictions, it is an unsafe practice to do this by adding the sign "Except Local Deliveries" (sign number R5-2-3) to the bridge restriction signs. The bridge cannot determine the purpose of the vehicle, only its load effect. The R5-2-3 sign is not to be used for bridges restricted due to condition.

- **Use of Special Hauling Permit to Exceed Posted Weight Limits**
  Chapter 191 of the PA Code has a provision to allow owners to issue special hauling permits to allow an individual vehicle to exceed the posted bridge weight limit. Such a permit is usually issued for a limited number of crossings after an analysis of that individual vehicle indicates it can safely use the bridge. This type of permit is used sparingly and is generally limited to critical emergency vehicles or snow removal equipment.

  For Department bridges, all vehicles, including snow plows and emergency vehicles, that exceed the bridge weight limit imposed under V.C. §4902(a) are required to have a permit issued in accordance with Chapter 191 of the PA Code. Each year before October, the District Bridge Engineer should advise the individual County managers of posted bridges in their area so they may adjust equipment assignments or obtain the necessary permits. Local bridge owners are strongly urged to proactively follow a similar policy for their bridges, especially ones that may be vital to emergency services.

4.4.6 Bridges on Routes Posted Due to Highway Conditions

Weight limit restrictions placed on a route solely due to highway condition (e.g., pavement condition) do not prevent all heavy vehicles from using that roadway or bridges located on it. For example, heavy trucks may receive a hauling permit or local delivery trucks exempted that allow trucks to use a bridge on a route posted for a weight limit due to the condition of the highway. Accordingly, all bridges with inadequate capacity to carry the legal loads must be posted separately and in addition to the highway posting.

4.4.7 Bridge Restriction Signing

4.4.7.1 VEHICLE CODE REQUIREMENTS FOR SIGNING

The PA Vehicle Code § 4902(e) requires that the Commonwealth and local authorities have restriction signs erected and maintained both at the bridge site and at locations in advance of the bridge.

The Vehicle Code also requires that an advance informational sign must also be placed at the intersection nearest each end of the restricted bridge to allow drivers to avoid the restricted bridge. Additional advance informational signs at other intersections may be considered where the alternate route closest to the bridge is not the desired detour. Signing must be done in accordance with the Manual on Uniform Traffic Control Devices (MUTCD) and the Department's Handbook of Approved Signs, Publication 236.

4.4.7.2 EXAMPLES OF BRIDGE RESTRICTION SIGNING

Figure IP 4.4.7-1 and Figure IP 4.4.7-2 are examples of proper signing at the bridge for restrictions established under Vehicle Code §4902(a) Restrictions Based on the Condition of the Bridge and are shown here for information only. Refer to the MUTCD and Publication 236 for further information on their configurations, use, and placement.

4.4.7.3 VERIFICATION OF BRIDGE RESTRICTION SIGNING

VERIFICATION DURING INSPECTIONS: The bridge safety inspectors are to verify the existence and condition of bridge restriction signing during each inspection on the *i*Forms Form A to ensure that this critical safety warning is in place. Any signing deficiencies are critical deficiencies and should be noted on Form M and/or appropriate action to rectify taken immediately (Maintenance Priority "0").

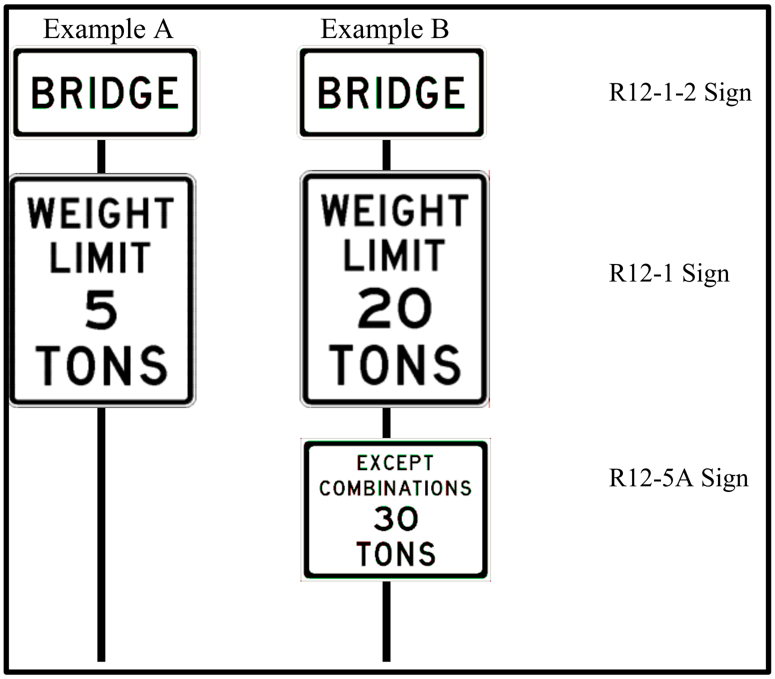

Figure IP 4.4.7-1 Examples of Signing for § 4902(a) Restrictions with Weight Limits

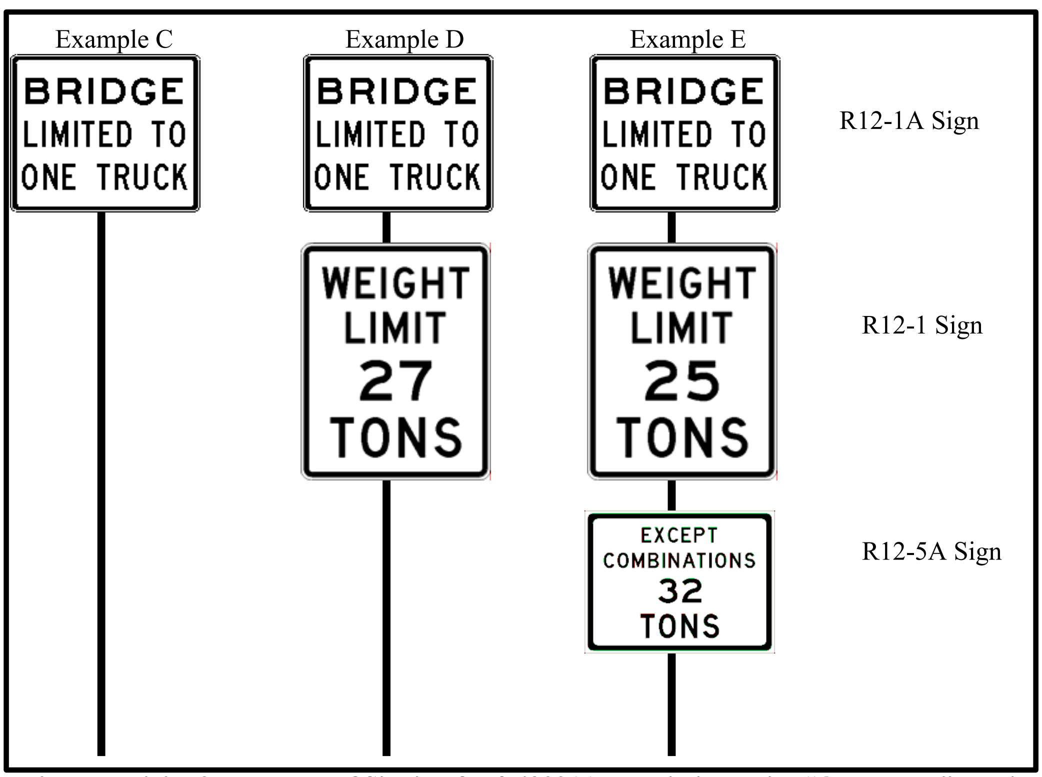

Figure IP 4.4.7-2 Examples of Signing for § 4902(a) Restrictions with "One Truck" Posting

4.5 WEIGHT RESTRICTIONS BASED UPON TRAFFIC CONDITIONS

Weight restrictions on bridges may be established based solely upon traffic conditions. Such restrictions are imposed under §4902(b) of the Vehicle Code and must not be related to the bridge condition. Warrants for such postings must be established in accordance with Chapter 212 of TITLE 67.

Allowing exemptions for traffic conditions postings to non-overload vehicles via the use of the “Except Local Deliveries” sign does not violate any structural safety concerns.

4.6 PROCEDURES FOR POSTING RESTRICTIONS ON DEPARTMENT BRIDGES

4.6.1 Applicability

These procedures apply to all first-time weight restrictions, lowering of existing weight restrictions, permanent bridge closures, “Bridge Limited to One Truck” restrictions, and removal of weight restrictions on PennDOT owned bridges equal to and greater than 8’.

For emergency situations, the District is to take actions it deems necessary for public safety. The formal posting authorization process should be completed shortly thereafter.

For bridges under PUC jurisdiction, the posting should be authorized by the Department at the appropriate authority level prior to the PUC proceedings. See the Grade Crossing Manual, Publication 371, for additional guidance on bridges under PUC jurisdiction. Publication 371 includes an example letter in Appendix A when posting a bridge under PUC jurisdiction.

4.6.2 Posting Approval Authority

The approval authority for bridge postings is based on the type of route carried by the bridge:

- Case 1: Interstate System Bridges – Secretary of Transportation.
- Case 2: Numbered Traffic Route (1-999) Bridges or National Highway System (NHS) Bridges – Director, Bureau of Maintenance and Operations.
- Case 3: Non-NHS Bridges and Other Bridges - District Executive.

For posting purposes only, bridges on ramps are to be considered part of the higher-level system to which they connect. For example, a bridge carrying an exit ramp connecting an Interstate to a local road would be treated as an Interstate structure.

4.6.3 Posting Approval Procedure

The District or their consultant is to inspect, analyze, and rate the bridges to develop the appropriate posting evaluation and recommendation. The District is also to review the impact of the proposed posting on emergency services and commerce.

The District is to compile the findings on the Bridge Load Posting Recommendation Form (see Appendix IP 04-A) and maintain the form in the bridge inspection file. The Bridge Load Posting Recommendation Form is to be signed by the District Bridge Engineer. The completed form shall reflect the actual inventory and operating ratings of the bridges; however, for bridges where the posting is based upon the use of a Safe Load Capacity Reduction Factor less than 1.0, comments and assumptions shall be noted on the Bridge Load Posting Recommendation Form.

For Case 1 or 2 (see IP 4.6.2), the District is to submit a posting authorization request to the Bridge Inspection Section Chief for review and recommendation to upper management (see Appendix IP 04-B for examples).

The posting authorization request letter must state that the bridge is to be restricted under §4902(a) of the PA Vehicle Code. Also, the reason for the restriction must be stated (see IP 4.3.1.1 for examples).

The posting authorization request letter is to include the following attachments:

- Completed Bridge Load Posting Recommendation Form.
- Load Rating Summary Form.
- Site Maps: Portion of State Map and portion of Type 10 County Map.

The Bridge Inspection Section Chief is to review the District's data and forward a recommendation to the Director or the Secretary, as appropriate. The signed posting authorization letter will be sent to the District Executive with copies to the Program Center, and to the Grade Crossing Unit in the Bureau of Project Delivery for bridges under PUC jurisdiction and must be saved in the bridge inspection file.

For Case 3 (see IP 4.6.2), the District Executive is to review and approve the recommendation of the District Bridge Engineer. (See Appendix IP 04-B for a sample Posting Authorization Request Letter). Copies of the posting approval letter are to be sent to:

- Chief of the Asset Management Division, BOMO
- Chief Bridge Engineer, BOPD
- Bridge Inspection Section Chief, BOMO
- Grade Crossing Unit in the Utilities and Right-of-Way Section for bridges under PUC jurisdiction
- Director of the Center for Program Development and Management

The District is to maintain a copy of the bridge posting approval letter in the bridge file. For Districts with a District Executive who is not a Professional Engineer, the Assistant District Executive for Design (a Professional Engineer) must review and sign the posting authorization.

The Bridge Inspection Section (BIS) will perform a quality assurance review on a minimum of 50% of all bridge postings approved by the Districts. See IP 06 for additional information on quality measures for safety inspections.

4.6.4 Implementation of Posting

After the need for a posting is identified, the District shall complete the implementation of the posting in the field within 30 calendar days. The need for a posting is identified by the date the load rating set was sealed. Sign description and placement information shall be entered into BMS2 as soon as the fieldwork is complete. Coding changes within the appropriate screens must be entered at the same time.

The District is to ensure that elected and public officials, and emergency services personnel are informed of all posting actions.

Public information efforts are to be initiated by the Districts in consultation with the Central Press Office. Public announcements of postings shall provide reasons in words readily understood by the public.

4.6.5 Posting Documentation for Police

The District shall give full cooperation to both state and local police in the enforcement of the bridge weight restriction. Documentation stating the reason for the bridge weight restriction is to be submitted to the Pennsylvania State Police (PSP) for their use in enforcing the restrictions.

This posting documentation is to be in the form of a letter on Department letterhead from the District Executive to the PSP barracks having jurisdiction over the area where the restricted bridge is located. A new posting documentation letter is to be sent to PSP whenever bridge restrictions are initially placed, existing restrictions revised, or removed. The letter is to include the following:

- Bridge location in subject area.
  - Include: County, SR________over_______, Segment______Offset______.
- Bridge weight restriction.
  - Cite applicable section of the Vehicle Code (e.g., §4902 (a)).
  - Use format for bridge restriction as per IP 4.3.1.1.
  - Note if this is an initial restriction on the bridge or a change to an existing restriction.

- Reason for bridge weight restriction.
  - See IP 4.3.1.1 for format.
  - Emphasize public safety.
  - Do not include summary of bridge ratings or other bridge inspection related information.
- For bridges that are to be posted by a PUC order, include a statement that the PUC order is based on an engineering study performed by either the railroad or PennDOT.
- Provide the following two authorizing signatures.
  - District Bridge Engineer's signature and PE Stamp.
  - District Executive's signature.
  - If District Executive is not a Professional Engineer, then Assistant District Executive for Design signature.
- In addition to internal distribution, provide a copy of the posting letter to:
  - Bridge Inspection Section Chief.
  - PUC, for bridges under PUC jurisdiction.
  - County Maintenance Manager for installation and maintenance of signage.
  - A copy of this posting letter with original signatures and PE Stamp shall be maintained in the District Bridge Inspection File.

4.6.6 Other Considerations for Posting Evaluations

Alternatives to postings, including, repair, temporary shoring, temporary/permanent strengthening, etc. should be considered for all bridges, especially those that seriously impact emergency services and/or commerce. For Interstate bridges, the District must provide a summary of alternatives studied with the Bridge Posting Recommendation Data Sheets.

Bridges on the Tandem Trailer Truck Network or on the access roads to that network, identified in BMS2 Items 6C16 and 6C14 as TTTN and ATTT respectively, should be given additional consideration if not on a Numbered Traffic Route.

While the number of lane live loads on a bridge for analysis is normally the same as for design, using only the delineated lanes may be allowed by the Bridge Inspection Section Chief to minimize or avoid a weight restriction.

When bridges are to be closed, analyze and note whether pedestrian use of the bridge will be allowed. If not allowed, adequately barricade the bridge to prevent pedestrian use.

4.7 PROCEDURES FOR POSTING RESTRICTIONS ON LOCALLY-OWNED BRIDGES

4.7.1 Applicability

These procedures apply to all first-time weight restrictions, changes to existing weight restrictions, permanent bridge closures, "Bridge Limited to One Truck" restrictions, and removal of weight restrictions on locally-owned bridges.

For emergency situations, the local bridge owner or their consultant is to take actions they deem necessary for public safety. The formal posting authorization process should be completed shortly thereafter.

For bridges under PUC jurisdiction, the posting should be authorized by the local bridge owner and the District notified prior to the PUC proceedings.

4.7.2 Posting Approval Authority

The bridge owner has responsibility and approval authority for the posting of its bridges to ensure public safety.

The Department is to ensure that all local bridge restrictions are in accordance with Department standards to avoid improper postings. This responsibility and authority to ensure proper posting was assigned to the Department through Act 44 of 1988 (see IP 1.6.3). The District, acting on behalf of the Department, must work closely with the local bridge owner and/or their consultant to ensure proposed bridge restrictions are proper before they are put in place.

If the local bridge owner fails to implement or maintain the proper bridge restrictions, the Department is obliged to act on behalf of public safety to correct the deficiency. The District is to immediately inform the bridge owner, in writing, of the need to correct the posting deficiency immediately with a copy of the letter sent to the Chief of the Asset Management Division. Facsimile notification is acceptable. The District will coordinate further needed measures with the Director, BOMO and the Bridge Inspection Section Chief. In the event of an emergency, the District may take necessary actions immediately. The District is to identify and invoice the local bridge owner for all non-reimbursed costs incurred by the Department.

4.7.3 Posting Approval Procedure

The local bridge owner or their consultant is to inspect, analyze, and rate the bridges to develop the appropriate posting evaluation and recommendation. The local bridge owner or their Consultant is also to review the impact of the proposed posting on emergency services and commerce.

The local bridge owner or their consultant is to compile its findings on the Bridge Load Posting Recommendation Form, (see Appendix IP 04-A) and maintain the signed form in the bridge inspection file. The Bridge Load Posting Recommendation Form is to be signed by a Professional Engineer.

Local Bridge Postings are to be submitted to the District Bridge Engineer for a QC review prior to final approval by the Local Bridge Owner to:

- Check for compliance with Federal and State Regulations and Policy.
- Facilitate reimbursement of costs for first-time postings on NBIS bridges.
- Coordinate with Districts any postings on locally-owned bridges carrying State Routes.
- Facilitate coordination with PUC for postings on bridges under their jurisdiction.

The District and local bridge owner are to maintain a copy of the bridge posting approval letter in the bridge file.

4.7.4 Implementation of Posting

After the need for the posting is identified, the local bridge owner shall proceed immediately with the implementation of the posting in the field within 30 calendar days. The need for a posting is identified by the date the load rating set was sealed. Sign description and placement information shall be entered into BMS2 as soon as the fieldwork is complete. Coding changes within the appropriate screens must be entered at the same time. Any required local ordinance or statute must be implemented to ensure proper enforcement and adjudication of violations.

The local bridge owner is to ensure that elected and public officials, and emergency services personnel are informed of all posting actions.

Public announcements of postings shall provide reasons in words readily understood by the public.

4.7.5 Posting Documentation for Police

The local bridge owner shall give full cooperation to both state and local police in the enforcement of the bridge weight restriction. Documentation stating the reason for the bridge weight restriction is to be submitted to the Pennsylvania State Police (PSP) for their use in enforcing the restrictions.

This posting documentation is to be in the form of a letter on official letterhead from the local bridge owner to the PSP barracks having jurisdiction over the area where the restricted bridge is located. A new posting documentation letter is to be sent to PSP whenever bridge restrictions are initially placed, existing restrictions revised, or removed. The letter is to include the following:

- Bridge location in subject area.
  - Include: County, SR________over_______, Segment______Offset______.
- Bridge weight restriction.
  - Cite applicable section of the Vehicle Code (e.g., §4902 (a)).
  - Use format for bridge restriction as per IP 4.3.1.1.
  - Note if this is an initial restriction on the bridge or a change to an existing restriction.
- Reason for bridge weight restriction.
  - See IP 4.3.1.1 for format.
  - Emphasize public safety.
  - Do not include summary of bridge ratings or other bridge inspection related information.
- For bridges that are to be posted by a PUC order, include a statement that the PUC order is based on an engineering study performed by either the railroad or local bridge owner.
- Provide the following two authorizing signatures.
  - Professional Engineer responsible for the restriction.
    - This may be a staff engineer from the local owner or from the Consultant.
    - PE stamp is to be affixed to the posting letter.
  - Local bridge owner's signature.
- In addition to internal distribution, provide a copy of the posting letter to:
  - Local owner bridge inspection file.
    - This copy should have the original signatures and PE stamp.
    - Maintain in file for enforcement purposes.
  - District Bridge Engineer.
  - PUC, for bridges under PUC jurisdiction.
  - Local bridge owner's maintenance forces for installation and maintenance of signage.
  - A copy of this letter with original signatures and PE Stamp shall be maintained in the local bridge owner's Inspection File.

4.7.6 Other Considerations for Posting Evaluations

Alternatives to postings, including repair, temporary shoring, temporary/permanent strengthening, etc., should be considered for all bridges, especially those that seriously impact emergency services and/or commerce.

Local Bridges carrying State Routes should be given additional consideration and postings coordinated with the District.

While the number of lane live loads on a bridge for analysis is normally the same as for design, using only the delineated lanes may be allowed by the Bridge Inspection Section Chief to minimize or avoid a weight restriction.

When bridges are to be closed, analyze and note whether pedestrian use of the bridge will be allowed. If not allowed, adequately barricade the bridge to prevent pedestrian use.

4.8 VERTICAL CLEARANCE RESTRICTIONS

The minimum vertical clearance for all bridges in PA is to be recorded in the bridge inspection report and in BMS2. The minimum vertical clearance shall take into account the structure, and any signs, utilities, or other appurtenances attached to the bridge. This information is to be verified during each routine inspection of the bridge. If changes in vertical clearance are noted, the vertical clearance needs to be measured, recorded and if necessary vertical clearance posting signs need to be installed or revised. Any signing deficiencies are to be noted in the IM screen form and/or appropriate action to rectify taken immediately (Maintenance Priority "0").

Sketches of the bridge clearance envelopes are to be maintained in the bridge inspection files at the District. The clearance envelope should show the actual vertical clearance at critical points such as edge of pavement, center of highway, outside edge of shoulder, and at changes in the bottom elevation of the bridge. Bridges such as rigid frame structures or arch structures may require special detailing.

4.8.1 Maximum Legal Height of Vehicles

Height restrictions for vehicles are subject to enforcement under §4922(a) of the Vehicle Code. The maximum legal height established by §4922(a) is 13’-6”. Vehicles that exceed the maximum legal height are not authorized to move on highways without a written permit authorizing such movement (see IP 10) subject to §4961 of the Vehicle Code.

4.8.2 Posted Vertical Clearances and BMS2 Recordation

The MUTCD states “the Low Clearance (W12-2) sign shall be used to warn road users of clearances less than 12 inches above the statutory maximum vehicle height.” Because the maximum legal vehicle height is 13’-6”, bridges or structures over highways should be posted for a size restriction when the vertical clearance is less than 14’-6”. Accordingly, all bridges with actual clearances under 14’-6” shall be posted with advance vertical clearance signs (W12-2). In addition, the W12-2A Clearance sign should be placed on the structure at the critical clearance whenever possible. If signs are not in place or are incorrect, it should be noted in the inspection report as a critical deficiency. The actual vertical clearance is to be rounded down to the next lower whole inch and recorded in BMS2 Items 6C20 and 6C21.

Inspectors should identify all possible locations where signs may be required and/or needed due to site conditions. For bridges over state routes, the inspection review engineer shall work with the District’s Traffic Unit to determine if a sign is warranted. If it is determined that a sign is not warranted, a memo stating the decision should be placed in the inspection file and all pertinent inspection data, IM Screen maintenance items, comments, etc. should be revised accordingly. For bridges not over state routes, the signing for vertical clearance is the bridge owner’s responsibility to determine if signs are required and coordinate with the roadway owner as necessary. The local consultant or in-house staff has the responsibility to make a proper recommendation.

The posted vertical clearance generally includes a 3” buffer from the minimum measured vertical clearance to allow safe passage of vehicles beneath the structure accounting for some vertical curvature in the roadway profile, frost action, and the possibility that the vehicle is bouncing. Additional buffer for the vertical clearance may be warranted when sag or crest vertical curves at the bridge reduce the effective opening for longer vehicles.

For overhead bridges (such as arches) where the vertical clearances vary significantly across a cross section of the highway, posting the bridge for vertical clearance at more than one point (i.e., at centerline and at edges of pavement) may be warranted.

Overhead bridges with posted vertical clearances shall have an advance sign (W12-2) placed at the nearest intersection or a wide point in the road to facilitate a vehicle detour or turnaround.

However, because non-route specific annual permits for loads up to 14’-2” height are legally allowed to travel on Pennsylvania roads without a review of the route, bridges under that vertical clearance may be struck by a driver obeying an issued permit. Advance signing at the nearest intersection or wide point in the road is also warranted for this case.

Because APRAS includes the 3” buffer for vehicles in excess of 13’-6” internally as part of its review process, the measured vertical clearances are to be entered in BMS2 Items 6C20 - 6C23.

Vertical clearance postings do not require approval beyond the District Bridge Engineer. The vertical clearance posting is to be noted in the inspection report, recorded in BMS2 and implemented by the District.

PennDOT Publication 236M, ‘Handbook of Approved Signs’, indicates justification and placement for the W12-2 and W12-2A signs.

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5.1 GENERAL

Pennsylvania's Bridge Management System 2 (BMS2) is a powerful management tool that records and stores bridge inventory and inspection data for Pennsylvania's bridges and enables Department managers to make key decisions concerning bridge inspection, maintenance, preservation, rehabilitation and replacement. The integrity of the BMS2 is directly related to the quality, accuracy and uniformity of the bridge inventory and condition data obtained through field inspections. BMS2 helps ensure public safety and allows PA to comply with the federally mandated National Bridge Inspection Program and National Tunnel Inspection Program.

BMS2 is composed of inventory and inspection items collected for various structure types including bridges, tunnels, culverts, sign structures, retaining walls and high mast light poles. These data items are explained in detail in PennDOT's BMS2 Coding Manual, Publication 100A. The system also has the ability to produce a wide range of reports including standard monthly statistics reports, standard menu driven reports, and customized user-generated reports.

BMS2 integrates and exchanges key data elements with RMS, MPMS and SAP/PM. BMS2 also stores bridge data that supports APRAS.

BMS2 supports the federally mandated National Bridge Inspection Program and National Tunnel Inspection Program which enables Pennsylvania to receive its Federal allocation of funds.

5.2 BMS2 DATA

Pennsylvania's BMS2 contains data information separated onto various screens. The screens are separated into inventory and inspection screens. Inventory screens generally contain information about the components that make up the bridge (i.e. type, size, location). The Inspection screens document the findings a bridge inspector would report while inspecting the bridge. All data required by the Federal Highway Administration is included in these screens plus additional data deemed necessary by the Department. Publication 100A provides detailed descriptions and coding for each data item.

Data that resides in BMS2 can come from any of three sources: direct data entry via keyboard or iForms, such as bridge condition ratings; data that is generated through system calculations, such as maintenance deficiency rating; and finally, data that is imported from other Department Management Systems, such as average daily traffic.

BMS2 also exports bridge data to other Department Management Systems. The exchange of data between Department systems occurs via automatic batch processes at either daily or weekly frequencies depending on data type.

BMS2 currently integrates with the Multimodal Project Management System (MPMS), the Roadway Management System (RMS), the Automated Permit Rating and Analysis System (APRAS), and the Geographic Information System (GIS) as indicated in Table IP 5.2-1.

Table IP 5.2-1 Integration of Data in BMS2

System	Data to BMS2	Data from BMS2
RMS	Traffic Volumes, Network Data, and Functional Classification	Bridge Location and Select Bridge Data
MPMS	Program and Budget Data	Select Bridge Data
APRAS	None	Bridge Clearance and Load Data
GIS	None	Select Bridge Data
SAP/PM	Bridge Maintenance Data	Proposed Maintenance

5.3 BMS2 REPORTING

5.3.1 Reporting Within BMS2

A wide range of reporting capabilities has been included in BMS2 in order to access and fully utilize the extensive amount of data it contains. BMS2 has the ability to produce standard, menu driven reports; customized, user-generated reports; and automatic monthly bridge statistics reports.

Automatic monthly bridge statistics reports serve to report, document, and monitor the number, condition, type, and ownership of all bridges in BMS2. These reports also serve as a basis to track trends or patterns that may be developing over time. For example, a comparison of monthly reports could be used to determine whether bridge maintenance needs have increased or decreased over the last five years on a statewide basis or within specific areas of the state. Department managers would then have a basis to consider changes to bridge maintenance program funding levels.

5.3.2 Crystal Reports

Crystal Reports is a report writer program that provides a user-friendly Graphical User Interface (GUI) environment to enable users to utilize previously defined reports or to create new reports. Frequently used report definitions can be "published" to a PennDOT web server where the data results can be refreshed and viewed by any authorized BMS2 user without having Crystal Reports software installed on their local workstation. To create new reports, Crystal Reports software must be on the user's desktop. The PennDOT web server can only be accessed by users with the Internet Explorer browser connected to the PennDOT network. BMS2 Crystal Reports accesses data from the DB2 version of the BMS2 database also used for APRAS.

Important features of Crystal Reports and the web server include:

1. Reports can be represented as charts or graphs as well as textual data.
2. Reports are rendered in color and can include graphical elements such as the PennDOT logo.
3. The web server interface provides a search capability and a hierarchical tree structure that allows you to jump directly to a particular report section or page.
4. In addition to hard copy prints, reports can be partially or fully exported to a number of standard desktop software formats such as Adobe, Excel, Word and plain text.
5. Reports can be "parameterized," allowing the user to easily filter the report to narrow the results. For example, reports can be filtered by District so that only the information for the selected district is contained within the report. By providing the capability to enter parameters, a single report can serve the needs of all District users.

The District Bridge Engineers are responsible to see that bridge inspection information is not inadvertently released through this reporting tool. Access to BMS2 data using Crystal Reports and the PennDOT web server is only available to PennDOT users and not outside agencies.

The Bridge Inspection Section (BIS) is responsible for authorizing user access to BMS2 and BMS2 data through the PennDOT web server for Department users. Users requesting access to BMS2 and BMS2 data through the PennDOT web server must follow the instruction in Publication 100A and submit to the BMS2 manager in the BIS. A user may have READER or PUBLISHER access. The form is available in Publication 100A.

1. A READER is a user who:
   a. Can access published reports on the PennDOT web server through their Internet Explorer browser and can adjust parameters to customize the report and specify output format (e.g., hardcopy print, Excel Worksheet)
   b. Must have access to PennDOT network
   c. Needs no Crystal Reports software on desktop to run published reports.
   d. Needs little or no formal training.

2. A PUBLISHER is a user who has the same capabilities as a READER and:
   a. Can add reports to the PennDOT web server for other users to run.

b. Must have a copy of the Crystal Reports Developer software on desktop.
c. Must have more advanced training in Crystal Reports.

The initial folder structure on the PennDOT web server provides a repository for statewide reports and locations for district-specific reports. An individual user can run queries using the report definitions in the statewide or District folders but cannot modify them without first copying to their folder.

5.4 DATA ENTRY & MAINTENANCE

The following organizations have the responsibility to maintain current information in BMS2 for the bridges in their jurisdiction:

Districts – All bridges on or over State Routes plus all bridges on or over local routes owned by counties, municipalities or other parties.

DCNR – All bridges owned by the Department of Conservation and Natural Resources.

PTC – All bridges on or over the Pennsylvania Turnpike.

BIS – All other bridges in the state owned by other state or federal agencies.

The table in Appendix L of Publication 100A provides the BMS2/APRAS RACF Security Authorization Profile for all BMS2 users. It indicates the appropriate BMS2 and APRAS capabilities for the full range of system users. Authorization for functions shown in parentheses ( ) will be granted if requested and if job duties include those functions. For persons or capabilities not shown on the Security Authorization Profile, additional justification must be submitted.

5.4.1 BMS2 Access

BMS2 access will be controlled by the Department's ECMS and the table in the preceding section concerning Authorized BMS2/APRAS Users. A "Request for BMS2/APRAS Access" form must be completed and sent to the BIS, Attention: BMS2 Manager. This form can be found in Publication 100A. The BMS2 Manager will approve correctly completed forms and forward them to the ECMS for entry. This process is only applicable to Department employees.

Access for non-Department users is controlled by the administration of their organization. Please refer to Publication 100A for more information.

5.4.2 BMS2 Deletions

Bridge records should not be deleted from BMS2. The BIS will retain records of bridges removed from inventory on ECS.

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6.1 QUALITY MEASURES

The bridge inspection process is the foundation of the entire bridge management operation and the bridge management system. Information obtained during the inspection will be 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 not only does it impact programming and funding appropriations but also it affects public safety. Therefore, the Department addresses this need with extensive formalized quality control and quality assurance procedures.

6.2 QUALITY CONTROL

Quality Control (QC) is the enforcement, by a supervisor, of procedures that are intended to maintain the quality of a product or service at or above a specified level. QC of the inspection of highway bridges is a daily operational function performed in each organization performing the safety inspections, including consultants, owners, and District Bridge Units. A set of effective QC procedures will provide for uniformity of inspection and recording methods and will ensure quality reports. To ensure statewide uniformity and consistency the Department shall provide basic inspection training and mandatory biannual refresher courses (See IP 07, Training and Certification Program).

Each bridge safety inspection organization (e.g. Department District Bridge Units, engineering consultant firms, or bridge owner's staff) is to have internal quality control procedures in place to assure that the public safety is maintained on the bridge and that the inspections are performed in accordance with NBIS/NTIS and Department standards. An effective quality control program for safety inspection shall address the following areas:

- Organization and Staffing.
- Review of Field Inspections.
- Office File Review.
- Bridge Maintenance/Rehabilitation/Replacement Needs.
- Annual Meeting with Bridge Inspection Staff.

A record of QC efforts (e.g. a QC Logbook) shall be maintained by the inspection organization.

6.2.1 Inspection Organization and Staffing

An effective QC program begins with assuring that an adequate, qualified and properly equipped staff is in place to address the primary functions of a bridge inspection program:

- Field Inspections and Final Report
- Bridge Analysis, Rating and Posting Evaluations
- Maintenance and Improvement Needs

Responsibilities of PennDOT personnel including the District Bridge Engineer and the Assistant District Bridge Engineer (ADBE) – Inspection are outlined within the following sections. Each district may distribute the work differently to achieve the same desired results. Therefore, when a responsibility is assigned to one of these individuals within this chapter, it indicates the ultimate responsibility resides with that individual, however, the task may be assigned to a delegate.

The District Bridge Engineer is to maintain a roster and organization chart of the staff addressing these primary functions. The District Bridge Engineer is to ensure that the staff meets NBIS/NTIS and Department requirements for certification, training, and experience. The staffing complement must be sufficient and properly equipped to ensure that inspections are performed in a timely manner and in compliance with NBIS/NTIS and Department requirements.

The District Bridge Engineer is to ensure that engineering consultants, bridge owners and Districts have the proper staff for the bridges assigned to them, see IP 2.1.

6.2.2 QC Review of Field Inspections and Final Reports

Review of the field inspections by the District Bridge Engineer and the ADBE - Inspection can be a most effective quality control measure. It can build a strong communication link between the inspectors and the reviewers. The required and recommended procedures and responsibilities for review of field inspections and acceptance of final reports are detailed below.

Bridge Inspection Team Leader

REQUIRED ACTIONS

- Upon completion of each field inspection and the entry of data and notes into *i*Forms, the Team Leader is to review their work and then upload the data to BMS2 where it will be stored in "Submitted" status.
  - For consultants, this will normally include an intermediate step for office review by the consultant's Project Manager.
- Upload inspection data to BMS2 and provide written notification to the bridge owner within 30 days.
  - For Department owned bridges, direct the notification to the Department's ADBE – Inspection.
  - For non-Department owned bridges, direct the notification to the owner of record and copy the Department's ADBE - Inspection.
- For Department personnel, upon the discovery of any critical or high priority structural maintenance activities, immediately contact the ADBE – Inspection.
- For consultant personnel, upon the discovery of any critical or high priority structural maintenance activities, immediately inform the contract Project Manager. The consultant shall contact the bridge owner within 24 hours as required by the standard scope of work for bridge safety inspections using the procedures described in the company Quality Control Plan.
  - Contact with the owner shall be made by a Professional Engineer.
  - For Department owned and non-Department owned bridges, inform the Department's ADBE – Inspection.
- Make special note of the existence of any condition ratings of 3 or less for Deck, Superstructure, Substructure, Channel and Culvert. For consultant personnel, inform ADBE – Inspection and/or bridge owner of the existence of these conditions by written notification (time frame for notification not to exceed 2 weeks). An expedited inspection report is preferred. Copy the ADBE – Inspection on all notifications concerning non-Department owned bridges. Bridges (or structures) with these condition ratings must be reviewed by the District Bridge Engineer.

Assistant District Bridge Engineer (ADBE) - Inspection (or delegate)

REQUIRED ACTIONS

- Review *i*Forms in "Submitted" status for accuracy and completeness.
  - All bridges in poor condition must be reviewed by a Professional Engineer before the report can be "Accepted" in BMS2.
- When review is complete, approve the report by placing it into "Approved" status in BMS2.
- Upon receipt of reports of high priority or critical deficiencies, immediately notify the District Bridge Engineer.

RECOMMENDED ACTIONS

- Once every three months, select a few bridges that were inspected during the previous quarter, and visit sites.
  - Reviews should focus on bridges in poor condition and bridges with high priority maintenance needs.
  - Using BMS2 Coding Manual, rate the bridge for condition and appraisal ratings.
  - Compare results with previous inspection reports.
  - Review field observations with the Bridge Inspection Team Leaders.
  - Enter comments and site locations in a QC log book.
- Review adequacy of reference materials and inspection tools with each inspection team.

District Bridge Engineer (or delegate)

REQUIRED ACTIONS

- Review and approve all critical and high priority maintenance needs and component condition rating (i.e., deck, superstructure, substructure or culvert) of 3 or less before final acceptance of the bridge inspection report in BMS2. This includes ensuring applicable fields on the Proposed Maintenance screen in BMS2 have been completed (see Section IP 2.14.4).
- Ensure bridges identified with a condition rating of a 3 or less have appropriately coded critical or high

priority maintenance items to improve the condition rating of the structure.

- Develop Plan of Action for each critical and high priority maintenance item. (See IP 6.2.4.1)

RECOMMENDED ACTIONS

- Conduct annual meeting with all bridge inspection staff, including consulting firms. (See IP 6.2.5)

Assistant District Executive (ADE) - Design

RECOMMENDED ACTIONS

- Once or twice (preferred) per year conduct meeting with ADE - Maintenance, District Bridge Engineer, ADBE – Inspection and Bridge Maintenance Coordinator
- Review recommendations for maintenance and improvements and completion of high priority and critical needs (see IP 6.2.4.2).

6.2.3 QC Review of Office File

The bridge files in the office should be reviewed to ensure that the information needed for bridge inspection is readily available. All documentation of inventory and inspection information should be kept in an orderly and retrievable manner. A sample plan for the Districts is suggested below. This can be modified for other organizations:

ADBE– Inspection (or delegate)

- Review the files for approximately 10% of the bridges inspected the previous month for completeness and accuracy.
- Every three months, review posted bridge lists and review the files for 10% of these bridges, which were inspected within the previous quarter to see that the file documentation is sufficient and agrees with the posting, and the rating is current with latest inspection findings.
- Review 25% of FCM bridge files to ensure information needed for a fatigue and fracture inspection is available one month before the upcoming inspection.

District Bridge Engineer (or delegate)

- Annually review the list of posted bridges to determine repair or replacement options
- Annually review Fatigue and Fracture Inspection Plan for District's FCM Bridges to develop rehabilitation/replacement strategies.

6.2.4 QC of Bridge Maintenance/Rehabilitation/Replacement Needs

6.2.4.1 QC OF CRITICAL OR HIGH PRIORITY MAINTENANCE NEEDS

District Bridge Engineer (or delegate) Responsibilities

- Respond immediately to all reported Priority 0 or 1 maintenance needs by first ensuring that public safety is protected and then by developing a Plan of Action to correct or repair the critical deficiency (see IP 2.14).

6.2.4.2 QC OF SCHEDULED BRIDGE MAINTENANCE (PRIORITY 2 THRU 5), REHABILITATION AND REPLACEMENT NEEDS

The determination of bridge needs (maintenance, rehabilitation, and replacement) by the inspection organization should be reviewed annually. A sample plan for the Districts is suggested below. This can be modified for other organizations:

ADE-Design:

- Review with the District Bridge Engineer the procedures to be used in the event of a bridge emergency for reporting and coordinating repairs.
- Review with the District Bridge Engineer the procedures for selection of candidates for bridge maintenance program and rehabilitation/replacement programs. Review accomplishments and identify concerns.
- Review how large differences in bridge inspection condition/appraisal ratings or posting recommendations from the previous inspection are handled by the ADBE - Inspection.

- Review completion of high priority or critical maintenance needs annually.

6.2.5 Annual Meeting with Bridge Inspection Staff

An annual meeting of field inspection staff with the District Bridge Engineer, ADBE – Inspection, and Ratings Engineer is recommended to ensure that the entire team is aware of the latest developments in safety inspection. Additional meetings should be considered if significant issues or concerns arise. The following suggestion is made for the Districts and may be modified by other organizations.

District Bridge Engineer

- Once a year review all Q/C comments and observations with entire bridge inspection staff including local inspection coordinator.
- This review may be scheduled following a session of the Refresher Course for Bridge Safety Inspectors that one or more of the inspectors have attended to apprise remaining staff of the latest developments and the Department's current emphasis.
- This review should be separate from the Statewide QA program's district close-out meeting.

6.2.6 Samples of Good Inspection Practices

Inspection teams shall review inspection files prior to field work and take copies of inspection files to the field. Team shall complete all condition and appraisal ratings and review other items for correctness if directed by the supervisor on Forms D-450 and D-491 or BMS2 printout.

Bridge inspection teams should be rotated so that a team does not inspect the same bridge on consecutive routine bridge inspections. Consecutive inspections by the same team could lead to complacency because of too much familiarity with the structure.

The Bridge Inspector's Supervisor shall review each report for completeness and uniformity. Load ratings shall be computed for any bridge which has changed due to section loss or recent repair, etc. or whose ratings were never computed.

6.3 PENNSYLVANIA STATEWIDE BRIDGE INSPECTION QUALITY ASSURANCE PROGRAM

Quality assurance (QA) is the verification or measurement of the level of quality of a sample product or service. The Statewide Bridge Safety Inspection QA Program is administered by the Bridge Inspection Section (BIS) within the Bureau of Maintenance and Operations (BOMO) in conjunction with its Bridge Safety Inspection QA Consultant.

The purpose of the Statewide Bridge Safety Inspection QA Program is to measure the accuracy and consistency of Pennsylvania's bridge safety inspections. The findings from this program are used to enhance or emphasize training needs in the state's bridge inspection training courses and to address any statewide bridge inspection anomalies.

The Department's Statewide Bridge Safety Inspection Quality Assurance Program consists of independently re-inspecting 20 NBIS bridges in each of 11 Districts and 10 bridges owned by other agencies (including PTC, DCNR, DRPA, DJBTC) each year. The 20 District bridges include 10 Department-owned and 10 locally owned structures. The bridges are selected at random using a representative statistical distribution of each District's bridge types. Typically, bridges selected do not require special equipment to inspect, have reasonable ADT's and are of a reasonable size to minimize the cost of reinspection and the overall cost of the Statewide Bridge Safety Inspection QA Program.

On each bridge, the ratings of 10 inspection items from the QA blind inspection are compared to the ratings from the original inspection. The original inspection item ratings are considered to be out-of-tolerance if they vary more than 1± from the ratings compiled by the QA team. Bridge capacity ratings are redone for all bridges having sufficient documentation to do so. Bridge capacity ratings are considered to be out-of-tolerance if they vary by more than 15% from the capacity ratings done by the QA team. For posted bridges, the bridge is considered to be out-of-tolerance if the posting evaluation varies by more than 2 tons from the QA team's posting evaluation.

Results of the QA inspections in the form of a draft District Summary Report are reviewed with the inspectors in each District during the District Close-Out Meeting. The Close-Out Meeting is an important part of the QA process because it encourages communication between the QA reviewers and the individual inspectors. Findings from the QA inspections, rating analyses and posting evaluations, and other bridge inspection related issues are discussed. The results of these meetings are used to emphasize training requirements, improve inspection techniques, and initiate needed changes to inspection and coding manuals and Department rating programs.

If the results of the QA inspections discover a common issue which requires clarification to all bridge inspectors statewide, the issue will be addressed via a link on the BMS2 homepage. Inspectors shall check this link frequently for the latest information.

The results of the QA Close-Out Meeting are incorporated into the report and the Final Report is distributed to the District. The final results of the QA review contained in the District Summary Report are a collaboration of the inspectors, consultants, BIS and the QA consultant.

When all District Summary Reports are finalized and distributed to the respective Districts, the annual Statewide Cycle Summary Report is compiled, and a copy is distributed to each District.

The Statewide Cycle Summary Report is a compilation of all the Districts' QA results. This compilation gives an indication of statewide trends in bridge inspection. Any consistent problems are identified and corrected through the following means:

- Revisions to Procedures and Manuals
- Bridge Inspection Basic and Refresher Training Courses
- Other Bridge Inspection Related Courses

6.3.1 Procedures for the Statewide Bridge Inspection QA Program

The procedures for the quality assurance review for each of the Districts' and the other agency owners' designated bridges consists of six tasks for the QA consultant as outlined below:

- **Task I - Office File Review** - The office evaluation shall include the following:
  - General Bridge File Content - complete a bridge file checklist for each bridge that indicates critical contents of bridge inspection records, including but not limited to rating computations, posting evaluation and documentation, drawings, inspection reports, etc. (See Chapter IP 8 for Bridge Inspection File contents).
  - Inventory and Inspection documentation (D-450 Forms) comparison with the data in the BMS2.
  - Load rating analysis comparison with data entered in the BMS2.
  - Compliance with posting policy (agreement with the Inventory and Operating Ratings in BMS2).
  - Verify that *i*Forms form M has been completed, especially with regard to critical deficiencies, narrative comments, and identification of maintenance needs.
  - Verify and highlight that a need for bridge cleaning as directed by IE 4.3.5.2 is being identified when necessary and note if cleaning has been performed.
  - Contact BIS to obtain copies of shop drawings referenced but not available at the District Office.
  - Determine if field measurements are needed to complete an independent load rating analysis (Task III).

- **Task II - Field Inspection** - Field inspection shall include a complete NBIS inspection of all selected bridges. Each inspection shall include:
  - Verify and identify the structure.
  - Provide maintenance and protection of traffic if needed.
  - Photograph the structure.
  - Verify BMS2 inventory data.
  - Verify safety features and posting signs.
  - Perform independent condition/appraisal ratings.
  - List and prioritize maintenance/repair needs. Conduct Maintenance needs assessment.
  - Take needed field measurements for bridge load rating analysis.

- Prepare field sketches for scour conditions.

- **Task III - Load Rating Analysis, Posting Recommendations, and Comparison with Existing.**
  - Load rating analyses will be performed for those bridges with sufficient information to do so in the bridge inspection file. Typically, load rating analyses are done for two-thirds of the bridges inspected. Some field measurements may be needed during Task II to supplement the office file data. The load rating analyses shall be done using the Load Factor Method of analysis.
  - The QA load rating analysis shall be performed independently of the current load rating analysis in the bridge inspection file. The QA office file review and field inspection teams must have obtained sufficient data to perform the load rating analysis.
  - The analysis shall include Inventory and Operating Ratings for H20, HS20, ML80, and TK527 vehicles.
  - All calculations, both longhand and by computer, and any sketches are to be documented neatly and included in the QA load rating analysis.
  - Any computer input files and supporting calculations are to be included in the QA load rating analysis.
  - Compare these load rating analyses with those in the bridge inspection file and highlight any out-of-tolerance differences. List any inaccuracies, omissions or errors.
  - Comment on existing or required load posting.
  - Be prepared to discuss differences in results or methods at the close-out meeting.

- **Task IV - Preparation and submission of Draft Summary Reports.**
  - This task includes a draft of the Summary Report, the individual bridge inspection reports, and the bridge load rating analyses for each District and other agencies.
  - The Summary Report contains a discussion about the bridge file, bridge inspection, load rating analysis, and maintenance needs assessment for each of the bridges reviewed. Recommendations and conclusions regarding the District's effort are also included in this Report.
  - The draft version of the Summary Report, the bridge inspection reports, and a set of the bridge load rating analyses are sent to the District for their review.

- **Task V - Field View and Close-Out Meetings.**
  - A Close-Out Meeting is scheduled with each District to discuss the findings of the QA review. A field view of several of the bridges selected for the review may be performed by the QA consultant and the BIS personnel prior to the scheduled meeting.
  - Recommended attendees of the Close-Out Meetings include: ADE-Design, District Bridge Engineer, District Inspection Staff including local bridge inspection coordinator, local bridge owners and their inspection consultants.
  - Using results from the field view and the Close-Out Meeting discussion, the Summary Report, bridge inspection reports and bridge load rating analyses are finalized and submitted to BIS for review. The reports and ratings are then distributed to the District.

- **Task VI – Cycle Summary Reports.**
  - After Tasks I through V have been completed for all the Districts and other agencies, 3 Cycle Summary Reports, (one statewide report for Department bridges, one statewide report for Local bridges, and one for the other agency-owned bridges) are prepared and submitted to BIS for review and distribution to the Districts and other agencies. The Statewide Cycle Summary Report includes:
    - A compilation of both Statewide results and individual Districts' results for the past QA Cycle
      - Out-of-Tolerances for Condition and Appraisal Items
      - Out-of-Tolerances for Observed Scour Ratings
      - Out-of-Tolerances for Bridge Capacity Ratings
      - Omissions of Maintenance Needs recordation
    - Findings
      - Condition and Appraisal Items that are consistently out-of-tolerance are noted and discussed
      - Discrepancies between the D-450's and the BMS2 D-491 Screens are noted

- Out-of-Tolerances for Observed Scour Ratings are discussed; especially noted, are the sub-items that makeup this Item that are consistently coded incorrectly.
- Conclusion and Recommendations

6.3.2 Selection of Bridges for Statewide Bridge Safety Inspection Quality Assurance Review

The bridges selected for the QA review shall be chosen by a random selection process using a representative statistical distribution of each District's bridge types.

Each District will be required to provide input as to the ten locally owned bridges to be reviewed. BIS will select the ten state-owned bridges for each District and the ten agency bridges.

6.3.2.1 LOCALLY-OWNED BRIDGE SELECTION GUIDELINES

The locally owned bridge selection guidelines are as follows:

- Bridges selected should be from normal NBIS inspections that were performed preferably within the 9 months prior to the submittal date established by the Department. If necessary, this 9-month period may be extended to 12 months in order to obtain a sampling of a District's local bridge inventory in accordance with the items listed below.
- Bridges selected should be generally representative of a District's local bridge inventory.
- At minimum 5 selections for each consultant, unless that consultant is performing inspections in more than one county.
- Consultants not previously included in the QA process are preferred.
- Avoid selecting bridges over railroads where there could be possible problems with access or obtaining permission.
- If needed, selections can be made to place emphasis on a specific bridge type, inspection team, or geographic area.
- Bridges must have final inspection reports that have been received and accepted by the District.
- Reasonable effort shall be made to avoid selecting structures that were reviewed in previous QA cycles. The District shall contact BIS to obtain a list of bridges which have been subjected to a QA review in the past.

After determining what local bridges are to be reviewed for the current cycle, submit the list of structures to BIS. Location maps, preferably Type 10 County Maps with the selected bridge marked, are to be provided for each bridge site.

A request for reduction in the number of local bridges to be reviewed must be justified. Possible justifications may include: a small pool of inspections that have recently been performed, a large number of the same types of bridges being inspected, the same consultant having performed all inspections or the past performance of the consultant. If a submission of fewer than the required 10 bridges is selected, a letter of justification must be sent to BIS two weeks prior to the District's submittal date.

The due dates for the Districts to provide input as to their 10 locally owned bridges to BIS will be distributed via email from BIS well in advance of the deadline for submission.

6.3.2.2 STATE-OWNED BRIDGE SELECTION GUIDELINES

The state-owned bridge selection guidelines follow the same guidelines used for selecting locally owned bridges.

6.3.2.3 OTHER AGENCY-OWNED BRIDGE SELECTION GUIDELINES

Ten other agency-owned bridges will be selected by BIS from the Western, Central, Eastern, or Northeastern portions of the state.

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7.1 GENERAL

The Department provides several bridge inspection training courses as well as a bridge inspection certification program for its bridge safety inspectors and supervisors. These courses are briefly discussed in the following section. For additional information including prerequisites and learning outcomes, check the Training Calendar in ECMS (at https://www.ecms.penndot.gov/ECMS/).

The District Bridge Engineer is responsible to see that all Department personnel performing safety inspections are trained and qualified at the appropriate level. The District Bridge Engineer is to ensure that all bridge owner or consultant staffs performing NBIS/NTIS safety inspections in their Districts are qualified at the appropriate level. The Bridge Inspection Section Chief is responsible to ensure those consultants and other State or federal agency personnel performing NBIS/NTIS safety inspections on statewide open-end agreements or other agency bridges are qualified at the appropriate level.

The Department does not provide any training classes for safety inspection of tunnels. The tunnel inspection training course, NHI 130110 is available through FHWA.

7.2 BRIDGE SAFETY INSPECTION COURSES

7.2.1 PennDOT's Bridge Safety Inspector Certification Course

PennDOT's Bridge Safety Inspector Certification course is intended to provide first-time certification of bridge safety inspectors and to impart the basic knowledge and skills necessary to accurately report on bridges for statewide uniformity. The course includes ten days of comprehensive training based on the FHWA training guide to satisfy the requirements outlined in the NBIS. An additional four days of training is included to cover PennDOT specific practices and procedures. The certification expires in two years, requiring inspectors to take the Bridge Inspection Refresher Course (see IP 7.2.2) to maintain their certification. FHWA has approved the course as comprehensive and equivalent to the two-week NHI training.

7.2.2 Bridge Inspection Refresher Course

The Bridge Inspection Refresher course is a three-day training which is intended to update the certification for a bridge safety inspector. This training provides a review of inspection and reporting procedures as well as information on special topics and updated to Department policies. The certification expires in two years, requiring inspectors to repeat the course to maintain their certification.

7.2.3 PennDOT Bridge Inspection Practices and Procedures

The purpose of the PennDOT Bridge Inspection Practices and Procedures course is to allow bridge inspectors who have successfully completed the ten-day FHWA-NHI Safety Inspection of In-Service Bridges course (#130055, #13055 or #13055A equivalents), to fully satisfy PennDOT's training requirements for a Certified Bridge Safety Inspector (CBSI). The certification expires in two years, requiring inspectors to take the Bridge Inspection Refresher Course (see IP 7.2.2) in order to maintain their certification.

7.3 OTHER TRAINING COURSES

7.3.1 Fracture Critical Inspection Techniques for Steel Bridges

The Fracture Critical Inspection Techniques for Steel Bridges is an NHI course (#130078). The Department offers this course periodically as needed for commonwealth employees and consultants. The training covers the concept of Fracture Critical Members (FCMs), FCM identification, failure mechanics, fatigue and an overview of Non-Destructive Testing (NDT) methods. The course also includes a hands-on workshop for popular nondestructive evaluation equipment and a case study of an inspection plan for a fracture critical bridge.

7.3.2 Bridge Scour Evaluation

The purpose of the Bridge Scour Evaluation course is to train bridge inspectors and supervisors to recognize, understand, evaluate and report actual and potential scour conditions based on the procedures described in the BMS2 Coding Manual. This training is offered on an as-needed basis.

7.3.3 Load Rating Analysis of Highway Bridges

The two-day Load Rating Analysis of Highway Bridges course presents details on when and how to perform a load analysis on highway bridges to conform to Department requirements and to ensure safe load posting. It also instructs the participants where to find information required to perform a rating analysis. This course does not teach participants to use PennDOT's load rating software.

7.3.4 BMS2 *i*Forms

The Department's BMS2 iForms course provides bridge inspection personnel with a high-level overview of Inspection Data Management in BMS2 and a screen-by-screen review of *i*Forms. It is a two-day class offered on an as-needed basis.

7.3.5 Other Bridge Inspection Related Courses

Other bridge inspection related training courses may be offered from time to time as they become available or as warranted.

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8.1 PURPOSE OF INSPECTION RECORDS AND FILES

Owners are to maintain complete, accurate, and up-to-date records for each of their bridges. These records are needed to:

- Establish an inventory of infrastructure assets
- Document the condition and functionality of infrastructure, including the need and justification for bridge restrictions, for public safety
- Identify improvement and maintenance needs for planning and programming
- Document improvements and maintenance repairs performed
- Meet documentation requirements for work performed using Federal and State funding
- Provide available information in a timely manner for safety inspections

The bridge inspection file is an integral part of an effective bridge inspection and management system. The information in the bridge inspection file is kept current through bridge inspections scheduled at regular intervals. As bridge inspection files are updated, the existing information is archived and retained to establish a history for each bridge.

The inventory data is required by the NBIS under Section §650.315 and by the NTIS under Section §650.515 which states the minimum interval after the inspection for inventory data to be submitted to the State or Federal agency. PennDOT requires that iForms be submitted to BMS2 for the Department's approval within 10 days of the completion of the field inspection for bridges and within 30 days for tunnels.

8.2 INSPECTION ORGANIZATION UNIT FILE

The Districts and individual bridge owners are to maintain a general file of their organization for bridge safety inspection. This general organization file should contain:

- List of bridges and structures*
- List of posted bridges* with date of most recent signing verification
- List of FCM bridges*
- List of bridges with special features and/or conditions that necessitate special or more frequent inspections*
- List of bridges that require underwater inspection*
- List of bridges to be inspected during/after high water events*
- Contact list for key staff during bridge emergencies
- Inspection organization
  - Organization Chart
  - Staffing with inspection certification credentials indicated
  - Internal inspection QC plan
  - List of inspection equipment
  - Availability of bridge design and inspection reference material
  - Results of QA reviews

* May be generated from BMS2 data

8.3 INDIVIDUAL STRUCTURE INSPECTION FILE CONTENTS

The inspection file for each bridge/structure shall consist of a wide variety of information from several sources to ensure sufficient information is readily available for safety inspections and overall bridge management. Because sources for most of the bridge information is more short-lived than the bridge structure itself, it is important that the inspection file becomes the final repository from which information on the bridge's design, construction and maintenance can be retrieved to better evaluate current conditions.

The inspection information for individual bridges or set of bridges need not be located in a single central file. In fact, the wide variety of formats (including: 8 ½" x 11" paper reports, 22" x 34" mylar/vellum drawings, microfilm aperture cards, microfiche, electronic drawings/documents, photos prints/negatives/digital images and Department management system databases to name but a few) now in use for these records make a "single file drawer" concept for file management impractical. For the purposes of this section, the generic term "Inspection File" is intended to encompass all of these records wherever they are physically stored.

DISTRICT FILES FOR LOCAL BRIDGES: For local bridges, the Districts are to maintain in their office, at a minimum, a copy of the last inspection, the current bridge rating and posting evaluation, and documentation of posting verification.

INSPECTION RECORD FILE INDEX: Because portions of the Inspection File may be stored in more than one physical location, an index of the information available is critical to enable the inspector to quickly access information needed to evaluate a structure. A good index for each bridge should identify the types of records available, their format, storage location, date of record, etc.

8.3.1 Inventory Information and Field Inspection Records

These records are typically generated through the routine safety inspection program activities and include for each individual structure:

- Inspection record file index
- Location Map
- D-491 Forms to document inventory information stored in BMS2
- Routine Inspection Reports include, but are not limited to:
  - Field inspection notes on D-450 Field Inspection Forms including narrative (Hard copy even if electronic record (i.e., *i*Forms) is available)
  - Inspection Photos (see Scope of Work)
  - Inspection Sketches
  - Clearance Envelope for bridges over highways or railroads
  - Waterway Opening Cross-section and Stream Plan sketch with soundings
  - Destructive and Non-Destructive Test Results
- Fatigue and Fracture Investigations include, but are not limited to:
  - Plan for Fatigue and Fracture Inspections
  - Determination of Remaining Fatigue Life
  - Fatigue/Fracture Inspection Reports
- In-Depth Inspection Reports
- Underwater Inspection Reports
- List of special equipment needed for inspection
- Tunnel-Specific Inspection Procedures
- Documentation and results of functional systems testing
- Documentation of utilities attached to the structure or those which may interfere with access
- Inspection procedures for complex bridges or underwater inspections

8.3.2 Load Rating Analysis

The Load Rating Analysis is part of the safety inspection of a bridge but is treated separately here to ensure the proper attention is given. The Load Rating Analysis shall include the following documentation:

  - Load Rating Summary Form, including Pennsylvania P.E. seal and signature
  - Supporting calculations including any hand-calculations and/or spreadsheets
  - Sketches showing member cross sections and section loss, if applicable
  - Computer output and input files
  - References to appropriate design, rehab or shop drawings
- Engineering Judgment Documentation, if applicable

A sample Load Rating Summary Form is provided in Appendix IP 03-C. The condition of the bridge and date of the inspection that the rating is based upon should be documented with the above. In addition, the summary information should be coded in BMS2 on the Load Rating screen. Critical information such as controlling member identification and associated section loss and section remaining data should be recorded on the load rating summary form and in BMS2 field IR19- Notes for all load types so bridge inspectors are aware of the critical section and its properties used in the analysis.

A sample assigned load rating approval form is provided in Appendix IP 03-D. A summary of the assigned load rating must be included in the bridge file as indicated in IP 3.5.1.2 for all bridges which have ratings assigned from the design.

8.3.3 Posting Evaluation

The Posting Evaluation records are part of the safety inspection of a bridge, but are treated separately here to ensure the proper attention is given to these critical records which include:

- Posting Evaluation
- Posting Recommendation Data Sheets
- Posting Approval Letter
- Related Correspondence

8.3.4 Design-Related Information

Information generated during the design of the bridge that should be incorporated into the permanent inspection file includes:

- Design plans for original construction or rehabilitation
- Design Computations
- Design Exception Approval letters (Used in Rating Appraisal Items)
- Foundation Report
- Surveys
- Special Provisions
- ROW Plans

8.3.5 Waterway and Scour-Related Reports

Reports that assist in evaluating the waterway opening and the bridge's resistance to scour include:

- Hydrology and Hydraulics Reports
- Observed Scour Assessment Report
- Scour depth computations (may be part of H&H or stand-alone calculations)
- Scour Plan of Action

8.3.6 Construction and Maintenance Records

Records regarding construction and maintenance to be part of the bridge inspection file may include:

- As-Built drawings
- Shop Drawings
- Material Certifications
- Technical Specifications
- Pile Hammer Approvals and Pile Driving Records
- Field Change Orders
- Jacking and/or Demolition Schemes
- Documentation of latent defects
- Maintenance Work Orders, Sketches
- Repair Records
- Construction Photos

8.3.7 Miscellaneous Documentation

Other documents that may be maintained as part of the inspection file include:

- Bridge Problem Reports
- PUC Documents
- Occupancy Agreement and/or Permit
- Miscellaneous Bridge-Related Correspondence
- Cost Estimates for Improvements

- Reports of Field and/or Laboratory Testing (including equipment type, manufacturer, serial number, calibration certificate, and operator)
- Meeting Minutes of Critical Deficiency Meetings with Owners
- Plans of Action for Critical Deficiencies

8.3.8 Field Preparation Documentation

Preparation requirements for the field phase of an inspection vary greatly. Variations may be due to structure type, site accessibility, traffic volume, or channel conditions. Documenting field preparation requirements can reduce budgets by maximizing mobilization efficiency. The following areas of preparation, where applicable, are to be documented for each bridge.

- <u>Required Tools and Equipment</u>
  Identify any specialized tool or piece of equipment necessary that is not ordinarily carried by the bridge inspector. Example tools might be extendable ladders, special non-destructive testing equipment, power tools, lights, special safety equipment, special underwater tools or diving gear.
- <u>Special Services</u>
  Record any special services that are required. Example services might be traffic control, structure cleaning operations, inspection access such as structure rigging, an under-bridge inspection crane, or special working platforms such as a barge.
- <u>Scheduling</u>
  Document specific scheduling needs for non-routine inspections. This includes manpower needs for larger structures that require an extended duration inspection effort with multiple inspectors, bridges subject to seasonal flooding conditions, fracture critical bridges where special services are required, and underwater bridge inspections.
- <u>Site Condition Considerations</u>
  Identify unique site conditions that require more than routine preparation. Unique site conditions include railroad property right-of-way restrictions, navigable waterway restrictions, high voltage transmission lines, unusually heavy vegetation, mud, pollution, insect or animal droppings, unusually high water level or unique traffic safety procedures.

For tunnels being inspected in accordance with the NTIS, additional field preparation documentation is required. The tunnel specific document shall at a minimum: define critical systems, establish specialized inspection procedures, establish procedures for direct observation of critical system checks and establish requirements for testing functional systems. For additional guidance, see Section 4.5 of the TOMIE Manual. See IP 8.3.1 above.

8.4 FILE MAINTENANCE

8.4.1 Record Retention Period

In accordance with OA Management Directive 210.5 and the approved Records Retention and Disposition Schedule the following is a list of guidelines for records retention:

1. Retention of paper bridge files shall be 7 years. After 7 years the files are to be sent to the State Record Center for storage.
2. Any file format which bears a signature or engineering seal is required to be in human-readable format (paper or microfilm).
3. Retention of electronic and microform bridge files shall be 100 years.

For Department bridges that are turned back, given or sold to local municipalities or private/public organizations, all bridge inspection file information shall be given to its new owner. The District needs only a file with contents similar to other local bridges. A record of the ownership transfer shall be maintained in the bridge file.

8.4.2 Retention Method

1. Microform shall be considered "human-readable" format and shall be maintained for the life of the structure.

2. The agency (District and Central Office) must submit all electronic inspection files to ECS for storage. This can be done using the Documents link in BMS2.
3. Electronic files and microform storage management is at the discretion of the agency (District or Central Office).

8.5 DEPARTMENT FORMS FOR INVENTORY AND INSPECTION

8.5.1 Structure Inventory Forms for BMS2 – D-491 Series

The D-491 series of forms are to be used to document the inventory information contained in BMS2. The D-491 series are organized to show the bridge inventory inspection information as it appears on the BMS2 Screens. The D-491 may be the only place certain items are documented outside of BMS2. See Publication 100A, Appendix F for a blank version of the D-491 forms.

A complete set of D-491 forms should be maintained for each structure to verify the BMS2 data. If the initial D-491 forms are not available, a hardcopy printout of the BMS2 screens should be maintained.

8.5.2 Field Inspection Forms for Bridges – *i*Forms

The Department developed the D-450 series field inspection forms to record condition/appraisal ratings of bridge components with narrative comments to support those ratings, element-level data and major improvement/maintenance needs in a uniform manner statewide. The following make up the D-450 *i*Forms:

- A – Site Data
- B – Deck and Superstructure Data
- C – Abutment Data
- D – Pier Data
- E – Element Data
- F – Fracture Critical
- G – Underwater Inspection
- H – Culvert Data
- J – Channel and Waterway Data
- K – Paint, Structure Appraisal and Load Ratings
- M – Maintenance Needs Data
- N – Notes
- O – Miscellaneous Other Structures
- P – Inspection Administration
- S – Sign Structures and High Mast Lights
- T - Tunnels
- W – Retaining Walls and Noise Walls

The *i*Forms have limited space for comments and shall be supplemented when the narrative needs to be expanded to fully document the bridge conditions. Additional pages of lined or quad ruled paper are appropriate for this use. Sketches to describe and record conditions and/or tables of measurements are also most useful for documentation. New photos of the structure and defects (see SOW) shall be included with dates and captions. To record fatigue and fracture inspection information, use PennDOT Form D-491 IF for BMS2 data and additional sheets for narrative.

8.5.3 Field Inspection Reports Using *i*Forms Software

The inspection report format of the Department's *i*Forms software for electronic data collection of bridge safety inspections is patterned after the D-450 series of inspection forms and can be used as stand-alone or in conjunction with the D-450s, D-491s and additional pages as per IP 8.4.2. A hardcopy of the *i*Forms field inspection report is to be maintained in the bridge inspection file.

8.5.4 Field Inspection Forms for Retaining Walls and Sign Structures

The Department *i*Forms are to be used for the inventory and inspection of retaining walls and sign structures.

Similar to bridges, sketches to describe and record conditions and/or tables of measurements are most useful for documentation. Provide a sketch of the sign structure and roadway features showing all clearances. Roadway centerline, lane widths, shoulders, and guide rails are to be shown. Vertical clearances over roadway pavement and shoulder breaks are to be indicated. This data is to be field verified at each inspection.

Use the following referencing nomenclature and refer to Appendix IP 02-D, Figure 1:

- Near side / far side:
  The NEAR SIDE of the sign structure is as indicated in Appendix IP 02-D Figure 2, "Sign Structure Identification".

- Truss Referencing:
  The four (4) chord truss system will be referenced to as (LF) lower front; (UF) upper front; (LB) lower back; (UB) upper back. The Panel Points will be numbered from left to right, while looking at the Near Side of the Frame.

  The three (3) chord truss system should be referenced as noted above, except that the back single chord is referred to as Mid-Chord. Example: The interior diagonal from upper chord (U6) to Mid-Chord (M7) should be labeled U6-M7.

General photographs depicting the sign structure and showing the approach roadway and alignment, plus a side elevation view, as well as photographs of defects, must be included as part of the report. A photograph of the sign message (each sign) is also required. All photographs shall include a date and caption.

8.6 ELECTRONIC DOCUMENT MANAGEMENT SYSTEM

The PennDOT electronic document management system, Enterprise Content Services (ECS), is a group of computer software and hardware tools that electronically capture, store, and index paper documents such as engineering drawings, photos, sketches, analyses, and other documents and bridge inspection and load rating analysis file information. Users can take an existing business workflow that involves routing, distribution and approval and automate the whole process cutting down on the turn-around time and improving on overall efficiency. A benefit of ECS is reduced storage space, processing time, transmittal time, queue time, and administrative support. Bridge specific documents stored in ECS can be accessed through the Documents link in BMS2.

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9.1 GENERAL

Many types of standard tools, personal protection, traffic control, special equipment, safety and first aid, and special vehicles are available to aid in the inspection process. Proper advance planning is essential to determining the inspection equipment required to adequately inspect the bridge in an efficient manner. Most inspection organizations have limited workforce resources – having the right equipment for the right job the first time will ensure those resources are used wisely.

Answers to the following questions will determine the proper inspection equipment needed:

- What type of structure will be inspected?
- What type of inspection?
- What method of inspection?
- What kind of equipment is needed to access the remote portions of the bridge?
- When will the inspection be done?
- What feature(s) does the structure intersect?
- What hazards may be encountered (traffic, weather, wildlife, etc.)?
- How will team members communicate if large structures have them separated?

It is important that inspection teams are outfitted with the proper equipment to:

- Facilitate personal and public safety during inspection of the structure
- Perform an efficient and accurate inspection of the structure
- Perform the proper level of inspection intensity
- Correctly record the conditions of the structure

Special equipment required and method of inspection, once it has been determined for a structure, should become part of the bridge inspection file for future use.

9.2 INSPECTION TOOLS AND EQUIPMENT

9.2.1 Bridge Inspection Equipment

FHWA's Bridge Inspection Reference Manual (BIRM) provides additional information on inspection equipment in Section 2.4. For tunnel inspection equipment guidance, see the TOMIE Section 4.8. The information in these reference manuals will assist the Districts, bridge owners and consultants in properly preparing for field inspections. Inspectors should not be limited to the equipment on these lists as special circumstances may necessitate the use of non-standard tools.

The Department maintains a statewide fleet of under-bridge inspection cranes for use on bridge inspections where access may otherwise be a problem (see IP 1.12).

9.2.2 Sign Structure Inspection Equipment

Most of the equipment needed for sign structure inspections is covered in the BIRM's standard tool list for bridge inspection.

The following equipment is needed or especially useful for sign structure inspections:

- Dye-penetrant testing kit (Must be used any time aluminum structural members are suspect, especially welds)
- 24-ounce ball-peen hammer
- Cans of cold galvanizing or zinc rich paint
- Binoculars (10 X 50)
- Magnet
- Dial-indicating Torque Wrench (0-300 in.-lb. range.)
- Pipe wrench
- Spanner wrench and 4 ft. pipe extension
- Wrenches (1/2" to 1- 3/4")
- Socket wrench and deep sockets (1/2" to 1- 3/4")

- Standard size nuts, washers, bolts and clips to replace missing components (to be provided by the Department).

9.3 INSPECTION SAFETY

Bridge inspection presents many hazards when working around the bridge site. The best way to avoid many of these hazards is to be well prepared for the conditions and be knowledgeable of the surrounding area. The following are some of the more common hazards to be aware of:

- Traffic – Many inspections are conducted while traffic is allowed to cross the bridge. Inspectors should always know in which lanes traffic is permitted to travel on the bridge, and inspectors should always stay within the confines of the traffic control pattern if provided. If no traffic control is available, inspectors should conduct their inspections from the shoulder of the roadway when inspecting the topside of the bridge and limit the number of times crossing the roadway to avoid oncoming traffic.
- Weather – Pennsylvania experiences extreme weather conditions in both the winter and summer. During the winter, inspectors should dress warmly and appropriately for the colder temperatures. Layers of clothing should be worn so that they may be taken off or added, depending on the temperature fluctuations. Inspectors should also be aware of icy conditions around the bridge site. Traversing through partially frozen streams and creeks presents treacherous footing conditions. The summer months in Pennsylvania may produce very hot and humid temperatures. Inspectors should drink plenty of fluids throughout the day to prevent dehydration, and sun screen or sun block should be applied to exposed skin to prevent sunburn.
- Wildlife – Pennsylvania is the home to many species of wildlife that may be harmful to the inspector when conducting bridge inspections. Snakes, such as copperheads and rattlesnakes, are poisonous and are present throughout most of Pennsylvania. Wasps, bees and hornets are also potential hazards in the field, especially for people who are allergic to bee stings. Ticks are another pest that lurk in tall grasses and brush. The deer tick carries the virus for Lyme disease and can cause serious health problems if undetected. Inspection personnel should check themselves for ticks and tick bites daily.
- Inspection Equipment – For some inspections it is necessary to use specialized equipment such as cranes, lifts, etc. to access bridge components. When operating inspection equipment, inspectors should obey all the manufacturer safety policies and procedures. Adequate training shall be provided to all personnel operating any type of inspection equipment. Operators should note where all potential obstructions (e.g., power lines) are located so they can be avoided.

Inspection personnel should know the potential hazards before they go out to each individual bridge site. In addition, they should also know where the nearest hospital is located and the phone numbers of emergency personnel in the area. Being well prepared for inspections will help inspection personnel to avoid potential dangers.

9.4 TRAFFIC CONTROL

Provide traffic control during the inspection as needed in compliance with the Department's Publication 213, Temporary Traffic Control Guidelines. Whenever possible, coordinate inspection effort when other work is planned at the site in order to minimize disruption of traffic.

Any anticipated lane closures should be coordinated in advance since the times for inspection may be restricted by the District Bridge Inspection Supervisor or District Traffic Unit due to anticipated traffic conditions.

For traffic control details differing from Publication 213, submit a sketch to the District for approval. These sites will be identified by the District.

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10.1 GENERAL

The efficient movement of goods and services within and through the Commonwealth necessitates that some vehicles may exceed the Size, Weight and Load provisions for vehicles specified in Chapter 49 of the Vehicle Code. In order to provide for some assurance of the safe movement of these large vehicles and to prevent damage to our highway and bridge infrastructure, it is the bridge owner's responsibility to review the vehicles and their possible effect upon the bridges on or over the intended route before approving its movement.

The regulations and procedures for issuing hauling permits for these oversize and overweight vehicles are promulgated in Chapter 179 Oversize and Overweight Loads and Vehicles of Title 67 TRANSPORTATION of the Pennsylvania Code. This section is not intended to be an in-depth review of those rather extensive and changing regulations and procedures, but more of a guide for the District bridge personnel and other bridge owners as they review the bridges on the proposed routes on these permit applications.

The Department's basic philosophy regarding oversize/overweight permit vehicles is to review every bridge on every route for every permit application. That means that the clearance of every bridge on the intended routes for permit vehicles will be checked to ensure that the vehicle will pass beneath the overhead bridge restriction. In addition, each bridge on the intended route will be structurally evaluated to ensure it can safely carry the load imposed by an overweight permit vehicle. If any bridge cannot safely accommodate the height or weight of a permit vehicle, that route is to be rejected.

The Department's Automated Permit Routing Analysis System (APRAS) (see IP 10.5) allows for the vast majority of these bridge checks to be made automatically using the bridge clearance envelope data and the bridge analysis program datasets stored in BMS2. The accuracy and safety of results of these reviews is heavily dependent upon the quality of bridge inspections and ratings.

In this Chapter, two generic terms will be used for brevity and are not intended to imply the more legalistic definitions used in the permit regulations.

- "Permit" will be used here to refer to the variety of hauling permits for oversize and overweight vehicles and not to utility occupancy related issues.
- "Vehicle" will be used here to represent both single-unit vehicles and combination (tractor-trailer) vehicles.

10.2 PERMIT CATEGORIES

The terminology in M 6B8 is not consistent with the PA permit regulations and Department procedures. Department terminology will be used in this Publication. For bridge review purposes, there are three basic categories of hauling permits: Single Trip Permits, Annual Permits, and Blanket Permits.

10.2.1 Single Trip Permits

Single Trip Permits are permits for the one-time movement of a non-divisible oversize and/or overweight vehicle on a specified route. Axle weights and spacings must be provided in addition to the physical dimensions of the vehicle.

Permit conditions may be imposed upon the permittee by the Department to reduce the load effect on the bridge and ensure the safety of the movement. The permit conditions are listed on the copy of the permit that must be carried in the vehicle. Permit conditions may include, but are not limited to:

- The permit vehicle being the only vehicle on the bridge
- Limiting travel to specific lanes
- Limiting vehicle to crawl speed across bridge(s)
- Temporary shoring of bridges

These permit conditions must be evaluated carefully to ensure they will achieve desired reductions on load effect to the bridge. In addition, the imposition of some of the conditions may have a negative impact on the overall traffic conditions that might preclude their use at particular sites. The Bridge Engineer should consult with the Traffic

Engineer for those cases. If a permit condition needed to ensure the structural safety of a bridge on the route cannot be effectively or safely put in place, the application for that route must be denied.

There are other specialized permits that are reviewed and processed for bridge structural safety issue reviews in a similar manner to single trip permits:

- Super Load – A vehicle having a GVW greater than 201,000 pounds, or a total length exceeding 160 feet, or a width greater than 16 feet. (Buildings being moved, drag lines, and other quarry equipment excluded).
- Permit to cross bridge with vehicle weighing more than the posted bridge restriction.

10.2.2 Annual and Seasonal Permits

Annual Permits are permits for individual overweight vehicles carrying specific types of cargos in specified vehicle configurations (including axle weights and spacings) on the applicant-specified routes and are granted for a period of up to 12 months. The applicant vehicle is checked for conformance to the specified configuration. The bridges on the permit route are checked through APRAS for a set of axle weights and spacings specified for that type of annual permit before the permit is issued. The Bridge Design and Technology Division (BDTD) determines the standard set of axle weights and spacings to be used for the structural check of the bridges. Once the annual permit is granted, the permittee may travel the approved route as many times as desired.

Since 1998, twenty-five overweight Annual Permit vehicles have been introduced to PA highways and bridges as a result of legislation. See Appendix IP 10-A for a list of Overweight Annual Permit Vehicles.

For the purposes of this manual, Seasonal Permits will be considered and treated as Annual Permits.

APRAS re-analyzes the bridges on the annual permit route on a regular basis to check for changed bridge conditions. The annual permit is revoked or re-routed by the Department if any bridge on the approved route fails one of these subsequent reviews.

Because the Department has less control over the number and movement of Annual Permit vehicles after the permit is issued than for single trip permits, the permit conditions (discussed in IP 10.2.1) used to reduce the load effect of overweight vehicles on bridges are not allowed to be used for Annual Permits. In addition, vehicles with an Annual Permit alone are not allowed to cross bridges posted at weight limits less than the vehicle GVW.

10.2.3 Blanket Permits

Blanket Permits are permits for individual overweight vehicles carrying specific types of cargo and with specified vehicle configurations (including axle weights and spacings) on a Department-designated network of routes, granted for a period of up to 12 months. BDTD determines the standard set of axle weights and spacings to be used for each of the Blanket Permit vehicles. The bridges on the designated Blanket Permit network are structurally reviewed on a regular basis through APRAS for a set of axle weights and spacings standard for that type of Blanket Permit vehicle. A list of bridges the Blanket Permit vehicles are not allowed to cross is issued with the permit. The applicant vehicle is checked for conformance to the specified configuration before the permit is issued. Once the Blanket Permit is granted, the permittee may travel the approved network as many times as desired.

Since 1994, four overweight Blanket Permit vehicles have been introduced to PA highways and bridges as a result of legislation. See Appendix IP 10-A for a list of Overweight Blanket Permit Vehicles.

APRAS re-analyzes the bridges on the designated Blanket Permit network on a periodic basis to check for changed bridge conditions. It is the responsibility of the Permit Office to send the responsible Motor Carrier the updated “Roadway Restriction List for Blanket Permits” attachment and any “Additional Route” attachment produced after Network analysis. It is the responsibility of the Motor Carrier to ensure a current copy of the “Roadway Restriction List for Blanket Permits” is attached to each Special Hauling Permit.

Because the Department has less control over the number and movement of Blanket Permit vehicles after the permit is issued than for single trip permits, the permit conditions (discussed in IP 10.2.1) used to reduce the load effect of overweight vehicles on bridges are not allowed to be used for Blanket Permits. In addition, Blanket Permit vehicles are not allowed to cross bridges posted at weight limits less than the vehicle GVW.

10.3 LOAD CAPACITY EVALUATION

The load capacity evaluation of bridges to carry commercial traffic is a critical safety issue and an important issue to industry. Two types of common commercial loads fall outside the envelope of the Bridge Posting Vehicle ratings performed for bridge safety inspection and are a special concern:

- Overweight vehicles – vehicles that exceed the applicable maximum gross weights specified in Chapter 49 Subsection C of the Vehicle Code.
- Vehicles with a GVW that exceed the bridge's posted weight restriction established under § 4902(a) of the PA Vehicle Code.

This section will discuss how the bridge analyses and the approval for the hauling permit process for these bridge overloads are accomplished.

10.3.1 Authorization for Overloads on Bridges

The District Bridge Engineer is authorized and responsible for the approval of overloads on the Department's bridges in the District.

For bridges on State Routes under the jurisdiction of the PUC, the responsibility and authorization for issuance of permits should be outlined in the PUC Order. Typically, it could be assumed that the responsibility for inspection and maintenance of the bridge superstructure includes the permitting authority. In the absence of such formal authorization, the Department should assume this authority under its obligation for the safety of the State highway users.

For other non-Department bridges, the bridge owner is responsible for the approval of overloads on its bridges.

For LOBSTORS (Locally-owned bridges on State Routes) or other non-Department bridges carrying State Routes, the owner may authorize the Department to review and issue heavy hauling permits for permit vehicles using the State Route to cross the bridge. This authorization should be in the form of a letter from the owner to the Department and is to be maintained in the District Bridge Unit files.

10.3.2 Maximum Permissible Load Effect on Bridges

The maximum permissible load effect of a permit vehicle on bridges after consideration of all permit conditions and pertinent analysis factors (e.g., LL distribution, impact, uplift, temporary shoring) is the SLC. All permit applications exceeding the SLC must be denied.

For bridges of special concern, and bridges with a superstructure and/or substructure condition rating less than or equal to 4, the SLC should be used as the upper bound of the load effect on a bridge.

10.3.3 Live Load Distribution for Permit Vehicles

The distribution of permit live load on the bridge is to be in conformance with provisions of this manual. All exceptions must be approved by the Bridge Inspection Section Chief..

SINGLE LANE DISTRIBUTION: The application of the single lane load case for simplified girder distribution factors on a multi-lane bridge is allowed when:

- The permit vehicle has no more than two wheel lines and its gage distance is not less than the AASHTO specifications
- It can be assured by conditions in the permit that no other vehicle will be on the bridge at the same time as the permit vehicle.

DISTRIBUTION BASED UPON LATERAL POSITION OF VEHICLE: The distribution of live load for 2 girder bridges or trusses may be based upon a specific lateral position of the permit vehicle relative to the normal traffic lanes to reduce the live load effect if it can be assured by permit conditions that the vehicles will be in that position on the deck. Examples of special vehicle positions include, but are not limited to:

- Permit Vehicle to Straddle Centerline – used to minimize live loading to longitudinal truss or main girder of 2 girder system
- Permit Vehicle to Stay in Rightmost Lane – may be used to limit live load effect on transverse floor beam or tie-girder.

Note: Requiring the permit vehicle to travel adjacent to curb may not be feasible if the approach pavement does not extend to the curb line. Overweight permit vehicles are not permitted to travel on approach shoulders.

CRABBING: Some motor carriers have proposed the use of "crabbing" the permit vehicle to attempt to reduce the live load effect on a bridge. Crabbing involves steering the rear end of the trailer so that the front and rear ends of the trailer are in different lanes.

NON-STANDARD GAGE: When the gage distance between wheel lines of the permit vehicle are not in accordance with AASHTO standards, the distribution of live loads must be carefully considered. For gage distances less than the standard of 6'-0", the AASHTO simplified line girder distribution factors (See IP 3.3.2) are not applicable. Other examples of vehicle configurations where the simplified line girder distribution factors may not work include: When small trunnion axles are used in place of dual wheels or when there are more than 2 wheel lines. For these and other non-standard vehicles, the Districts may use the lever rule (see IP 3.4.1), a refined method of analysis (see IP 3.4.2) or may request guidance from the Bridge Inspection Section Chief.

DUAL LANE TRANSPORTER: Dual Lane Transporters (DLT) are very large vehicles designed to spread the load out wide enough and long enough to meet bridge analysis load limits. They have multiple axles or trunnions side by side and usually take up more than one lane. They present an interesting challenge to bridge analysis in APRAS. For non DLT loads, the first analysis trial is usually with distribution factors based on two or more lanes loaded. Two lanes loaded with AASHTO type vehicles side by side performs similarly to a DLT. Therefore, analysis of a DLT, with AASHTO gauge and passing distances, can be performed by using half of the axle weight of the DLT axles with the distribution factor based on two or more lanes. For DLT's that have gauge and/or passing distances smaller than specified in AASHTO, an additional step is necessary. A lever rule analysis can be performed on varying girder spacings to determine the largest distribution factor for the bridges being analyzed. This can be used to calculate a multiplier that can be applied to the axle weights of the DLT. The multiplier provides a quick analysis method when importing the permit vehicle axle weights and spacing and bridges on the route from APRAS to stand alone ABAS.

10.3.4 Impact Load and Crawl Speed

In accordance with IP 3.2.3, impact loading must be included in the bridge evaluation of all permit vehicles.

A reduction in the impact factor to a minimum of 10% of the live load effect is allowed when permit conditions can assure that the vehicle crosses the bridge at crawl speed. For this purpose, crawl speed is defined as no more than 10 miles per hour with no acceleration or deceleration on the bridge. This last requirement normally necessitates stopping the vehicle well before the bridge and proceeding across the bridge at a steady rate. Use of an impact factor less than 10% must be approved by the Bridge Inspection Section Chief.

10.3.5 Uplift Under Permit Loads

Uplift at the end spans of continuous bridges is to be avoided because of the potential for damage to bearings not designed for uplift. The potential for uplift is much greater under the typically heavy axles of the permit vehicle.

Uplift is considered to occur if the total (live load + dead load) reaction is less than 10% of the dead load reaction alone. If the uplift cannot be mitigated by hold-downs or added dead load, the permit should be rejected.

10.3.6 Temporary Shoring for Permit Loads

A permit applicant may propose to provide temporary shoring and/or repairs at their cost to a Department bridge to provide the additional strength to allow their vehicle to cross the bridge safely that would otherwise be rejected. The permit applicant may even propose a temporary bridge to bypass or to span over the Department bridge.

Any such proposal for temporary shoring, bridge, etc., must be submitted to the District Bridge Engineer for approval as a condition to the permit. The proposal must:

- Be prepared and signed by a professional engineer licensed in PA
- Have adequate sketches or plans and be supported by engineering computations
- Have acceptable details
- Contain all necessary permits for work in the waterway, etc.
- Agree to remove any temporary supports or material as required by the Department
- Provide materials acceptable to the Department
- Be acceptable to the District Bridge Engineer

The Department retains the right to deny a permit application proposing temporary shoring, bridges, etc., and to revoke any permit issued if the materials and or workmanship of the required temporary shoring, etc., is not satisfactory to the District Bridge Engineer.

10.3.7 Load Evaluations by Permit Applicant

Superload applicants that receive a denial notice, and have fully optimized their vehicle and route, may perform a load rating evaluation on a Department bridge by a more refined analysis method. The load rating analysis must be performed by a professional engineer licensed in PA and familiar with bridge analyses. Load effects on all bridge components, not just the superstructure, shall be considered in this analysis. Companies that intend to provide these services must be a registered business partner in ECMS, as stated in IE 8.21 and must submit a Quality Plan. The company will also be responsible for performing pre- and post-move Other Special (Interim) Inspections as per IP 2.3.5 for the bridges on the route. The Department retains the right to deny the permit application if the evaluation is not acceptable to the District Bridge Engineer. The need for load rating bridge components other than the superstructure, and pre- and post-move inspections increases as the GVW of the permit vehicle increases. One or both may be waived by the District Bridge Engineer upon request.

10.4 POSTED BRIDGES AND PERMITS

As per IP 4.4, careful consideration of permit applications for overweight vehicles to use bridges restricted due to their condition (under §4902(a) of the Vehicle Code) must be made because of the potential for bridge failure.

Permit applications to cross bridges posted for reasons other than the condition of the bridge under V.C. §4902(b) should be reviewed in a similar fashion as unposted bridges and a special permit as per IP 10.4.2 is not required.

10.4.1 Bridges Limited to One Truck

When a bridge has a restriction of traffic limited to one truck at a time only without an accompanying weight restriction, an applicant can request a permit for an overweight permit vehicle.

10.4.2 Bridges with a Posted Weight Restriction

When a bridge has a weight restriction posted due to its condition, a special permit is required for a vehicle to exceed the posted weight limit. Paraphrasing from § 191 of TITLE 67 TRANSPORTATION of the PA Code:

- The posting authority may permit an over-posted-weight or over-posted-size vehicle or combination to use a bridge posted under 75 PA Consolidated Statutes § 4902(a) if it determines that:
  1. For all practical purposes, the vehicle or combination can reach its destination only via the posted bridge; and
  2. Analysis of the number of axles, axle weights, distance between axles, height, width and other data indicates that the vehicle or combination will not have a detrimental effect on the bridge.
- The permit may authorize a single trip, a limited number of trips during a 12-month period, or an unlimited number of trips during a period not to exceed three months.

Accordingly, the review and approval of such permits by the District Bridge Engineer for Department bridges is handled in much the same way as single trip permits, although a special application is required.

The posting authority may also authorize a special hauling permit when the vehicle or combination weight exceeds the posted bridge weight limit if the same two criteria listed above are met. For this case, the approved M-4902 Application/Permit to exceed Posted Weight or Size Limit must be on file with the posting authority or attached to the special hauling permit application.

10.5 AUTOMATED PERMIT ROUTING ANALYSIS SYSTEM (APRAS)

The APRAS system is designed for the electronic application and processing of special hauling permits by PennDOT users and its customers. APRAS utilizes client/server based and Internet technologies to provide for easy access to permitting information to Industry and the Department.

There are two ways to access the APRAS system, via the Department Network or via the Internet. Customers can apply for permits, search for and check the status of permit applications, and access additional support functions via the Internet or submit hardcopy applications to Department permitting staff who, in turn, access APRAS through their local PC Workstation on the LAN. PennDOT staff has the ability to enter permit applications, process applications, approve and deny applications, and manage the system.

Major components of APRAS of interest to the review of bridges include:

- **APRAS Database** contains all information required for permitting including permit applications, permits, routing data, permitting codes and restrictions, and other system management information. APRAS contains a representation of the RMS roadway network used for entering route information and for route analysis and generation. Selected bridge data from the BMS2 system for all structures carrying or over State Routes is in the APRAS database. It also contains the program logic representing the business rules to validate and process permits. The central database design ensures consistent, manageable application of APRAS business rules.

- **Route Prompting** is the mechanism by which permit route information is entered into APRAS. Route Prompting ensures that all routes on the application are based upon RMS roadway data and ensures their connectivity. It also provides the basic data structures which are used in the Route Analysis, tying them to RMS roadway data, and BMS2 bridge data (vertical and horizontal clearance envelope and live load capacity).

- **Route Analysis** ensures that a permit vehicle can travel safely over the route specified by comparing the vehicle dimensions and load data against the roadway and bridge information from RMS and BMS2. Route Analysis checks for roadway clearances and special restrictions on roadways (e.g., Posted and Bonded roads). It also identifies the bridges along the specified route and performs oversize and overweight checks for the bridge structures. The structural check of bridges is performed by the ABAS subsystem.

  Route Analysis is an important step in the approval process for a permit application. Once a permit has passed all administrative validation rules, it must then pass Route Analysis before it can be approved. If the vehicle load can safely pass Route Analysis, a permit can automatically be issued by APRAS. If problems in the route are encountered or if certain conditions require further review, the application is posted for manual review by Department permitting and bridge staff.

- **Route Generation**'s function is to find the optimal route for an oversize and/or overweight vehicle from a source point to a destination point, without traveling over any roads or bridges that cannot handle the load. This allows permit staff to choose an approved, system- generated alternative route for the permit vehicle.

- **External Systems - RMS, BMS2, SAP, CARATS, EngMgr:** APRAS depends on data from several Department systems for its validation of permit applications.

  - **RMS** is the source for all roadway information, except some information regarding canned routes, turn restrictions, etc.
  - **BMS2** is the source for all bridge related clearance and capacity information.
  - **CARATS** is the source for vehicle registrations.
  - **EngMgr** is the Engineering Dataset Manager and stores the engineering datasets used by ABAS.

Information from these systems is refreshed within APRAS every night. Since APRAS is very dependent on RMS and BMS2 data, the relationship between permitting and maintenance of RMS and BMS2 is critical. APRAS relies upon the data in these systems being consistent and accurate. Any inconsistencies in RMS or BMS2 data detected through APRAS must be modified within RMS or BMS2. APRAS also interfaces with the **SAP** system for its financial transactions.

10.5.1 APRAS Related Data in BMS2

CODING INSTRUCTIONS: Data from the BMS2 that is needed for APRAS is contained on BMS2 Screens SL, SS and SC. For coding instructions, see applicable sections of Publication 100A.

STRUCTURES REQUIRING APRAS DATA:

- Bridge Capacity Data: All bridges or structures greater than 20 feet in length that carry vehicular traffic on State Routes, regardless of structure ownership, are to have sufficient load capacity data to allow APRAS to perform structure reviews. This information may include capacity rating factors and engineering datasets for analysis/rating software.

- Restricted **Vertical Clearance:** All bridges or structures over State Routes with a vertical clearance less than 16’-0”, regardless of structure ownership, are to have vertical clearance data for the State Route in APRAS. This includes truss bridges with overhead members, sign structures over pavement or shoulder area of roadway, overhead utility bridges, etc. See Appendix IP 10-C for the APRAS Vertical Clearance Flowchart.

- Reduced **Horizontal Clearance:** All bridges or structures over 8 feet in length that carry State Routes, regardless of ownership that have a face to face barrier distance of 16’-0” or less are to have horizontal clearance data. Consideration should also be given to structures adjacent to State Routes and encroach upon the horizontal clearance from edge of pavement (e.g., retaining walls), regardless of structure ownership.

RESPONSIBILITY FOR APRAS DATA: The District Bridge Unit is responsible to maintain sufficient clearance information and/or live load capacity information for the structures requiring APRAS data as outlined above to enable APRAS to perform the Route Analysis for a permit load on State Routes, regardless of structure ownership. This may require the monitoring of the clearance envelope by District staff for non-Department structures over State Routes. For LOBSTORS or other non-Department bridges carrying State Routes, the Districts are to provide information not available from the bridge owner, if the District is authorized to grant permits. Also see IP 10.3.1.

10.5.2 Automated Bridge Analysis System - ABAS

The APRAS subsystem that performs the load evaluation of bridges under permit vehicles is called ABAS – Automated Bridge Analysis System. ABAS was designed to replicate the manual bridge review process used by the District Bridge Units before APRAS was available.

Basically, that manual permit review process for bridges had two components:

- Checking the bridge’s load capacity rating factor for HS vehicle against the maximum load effect of the permit vehicle as a ratio of the HS vehicle.
- Using a bridge analysis program to check the actual permit vehicle

Generally, the capacity comparison method was used for bridges for which an analysis was not readily available (e.g., complex bridges, bridges rated by engineering judgment) or as a threshold value to minimize computational efforts.

The BMS2 APRAS data allows the District to use either the capacity comparison method and/or the direct analysis method. For the direct analysis method, engineering datasets for the input data to the analysis and rating software must be established in bridge rating library on the Department’s Dataset Manager. If the bridge fails during the capacity comparison method, APRAS automatically runs the analysis programs using the input dataset and the axle weight/spacing data from the permit application. If the bridge fails the analysis program, the application is sent to the Bridge Unit for a manual review.

The District Bridge Engineer may determine that a manual review is to be required for all permits on a bridge and an indicator is placed on the SC screen that instructs APRAS to analyze the bridge, but not approve it. For manual reviews, the bridge reviewer must approve each permit individually. All permit applications that pass all analyses and have the Bridge Unit's approval on manual reviews are approved for the load capacity evaluation. Appendix IP 10-B contains an abbreviated flowchart of the ABAS load evaluation for simple spans to demonstrate the basic concepts used.

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Appendices for Chapter IP 01 Administration Consideration

IP 01-A Bridge Safety Inspection Program Strategic Plan

IP 01-B NBIS Code of Federal Regulations (CFR) Chapter 23 Highways - Part 650

IP 01-C NTIS Code of Federal Regulations (CFR) Chapter 23 Highways - Part 650

IP 01-D Local NBIS Inspection Notification Letter

IP 01-E BMS2 Inventory Items Eligible for Right-to-Know Law

IP 01-F General Scope of Work - Safety Inspection of State and Local Bridges

IP 01-G General Scope of Work - Safety Inspection of State and Local Tunnels

IP 01-H General Scope of Work - Underwater Inspection of Bridges

IP 01-I Minimum Inventory/Inspection Items for Non-Highway Bridges over State Routes

IP 01-J Guidelines for Preparation of Safety Inspection Agreements

Appendices for Chapter IP 02 Inspection Requirements

IP 02-A Scour Critical Bridge Monitoring Field Manual and High Water Inspection Weekly Report Form

IP 02-B BPR Form and Guidelines for Completing the BPR

IP 02-C Emergency Bridge Restrictions and Special Hauling Permits Action Plan

IP 02-D General Scope of Work - Safety Inspection of Sign Structures

IP 02-E Standard Practices Manual for Measuring & Documenting Scour During Bridge Safety Inspections

IP 02-F Action Plan for Emergency Bridge Closure

IP 02-G Inspection Procedures following Emergency Events

IP 02-H Fatigue & Fracture Plan

Appendices for Chapter IP 03 Bridge Analyses and Load Ratings

IP 03-A PA Bridge Posting Vehicles Table of Live Load Effects on Simple Spans (No Impact Included)

IP 03-B Guidelines for Live Load Rating of Selected Concrete Bridges Without Plans Using Engineering Judgment

IP 03-C Load Rating Summary Form

IP 03-D Assigned Load Rating Approval

Appendices for Chapter IP 04 Bridge Size and Weight Restrictions

IP 04-A Bridge Load Posting Recommendation Form

IP 04-B Posting Authorization Request Letter

Appendices for Chapter IP 10 Heavy Hauling Permits and APRAS

IP 10-A Annual and Blanket Permit Vehicles Authorized in PA

IP 10-B ABAS Abbreviated Flowchart for Simple Spans

IP 10-C APRAS Vertical Clearance Flow Chart

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APPENDIX IP 01-A

Bridge Safety Inspection Program
Strategic Plan

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Mission Statement

To ensure the public safety and efficiency of the bridge system throughout Pennsylvania by advancing bridge inspection policies and procedures, bridge management practices, emerging technologies, and partnerships with business partners.

Goals

To fulfill the mission, four goals with objectives and supporting strategies are defined as follows:

- Ensure all highway bridges are safe
- Support principles of Bridge Management
- Use bridge inspection technologies and equipment to supplement visual bridge inspections
- Strive for continual improvement

Goal: Ensure all highway bridges are safe.

1. **Objective:** Defined policy & procedures

   Strategies

   a. Defined inspection roles and responsibilities
   b. Defined critical deficiencies
   c. Defined inspection types
   d. Defined inspection methods
   e. Defined inspection intervals
   f. Defined inspection report
   g. Defined QC/QA program

2. **Objective:** Safety Inspections of Bridges

   Strategies

   a. Compliance with National Bridge Inspection Standards and PennDOT publications
   b. Proper inspection planning
   c. Thorough inspection and reporting
   d. Conduct fracture critical member inspections
   e. Conduct underwater inspections
   f. Provide consultant resources to Districts
   g. Provide consultant resources to local governments

3. **Objective:** Load Rating of Bridges

   Strategies

   a. Proper identification of need to re-evaluate load ratings
   b. Proper documentation of load ratings
   c. Provide Engineering tools
   d. Standardized Posting Evaluation Process
   e. Evaluate new software
   f. Correct problems in existing PennDOT software
   g. Support of APRAS -Evaluation of overweight permit vehicles
   h. Provide support to Districts for super-loads

4. **Objective:** Critical deficiencies

   Strategies

   a. Proper discovery and prioritization
   b. Develop Mitigation Measures
   c. Develop Structural Repairs

Goal: Support principles of Bridge Asset Management.

1. **Objective:** Data Management
   Strategies
   a. Inventory elements
   b. Conduct element level inspections for all state-owned bridges
   c. Ensure data quality
   d. Ensure data integrity
   e. Perform data analysis
   f. Develop data retrieval and reports

2. **Objective:** Information Intelligence
   Strategies
   a. Ensure accurate data/information for executive management decision making
   b. Align with Commonwealth and Department IT initiatives
   c. Develop data performance metrics

3. **Objective:** Bridge Planning for maintenance
   Strategies
   a. Establish systematic preservation program
   b. Address on-demand structural maintenance
   c. Conduct annual preventive maintenance
   d. Establish needs-based budgets or set-asides as function of assigned priority and/or cost-benefit
   e. Evaluate new materials and technologies and their effectives for bridge maintenance
   f. Provide the Districts an annual summary of the data included in the preservation program including maintenance recommendations

Goal: Use new bridge inspection technologies and equipment to supplement visual bridge inspections.

1. **Objective:** Structural Response
   Strategies
   a. Use appropriate technology to assess cause to develop structural repair
   b. Evaluate technology through state and national research programs
   c. Coordinate with FHWA Turner-Fairbank Research Center
   d. Participate on task forces to develop national policy
   e. Partner with universities and private businesses to use appropriate technology

2. **Objective:** Detecting Loss of Strength (Section Loss, Structural Cracking, Fatigue, Bearing)
   Strategies
   a. Use of non-destructive techniques and minimally invasion techniques
   b. Use of measurement devices
   c. Evaluate technology through state and national research programs
   d. Coordination with FHWA Turner-Fairbank Research Center
   e. Participate on task forces to develop national policy
   f. Partner with universities and private businesses to use appropriate technology

3. **Objective:** Standardized/consistent equipment
   Strategies
   a. Ensure bridge safety field inspectors use appropriate inspection and access equipment
   b. Use appropriate digital technology – mobile office
   c. Evaluate newly developed access equipment
   d. Evaluate technology through state and national research programs
   e. Coordination with FHWA Turner-Fairbank Research Center

Goal: Strive for continual improvement.

1. **Objective:** Training

   Strategies

   a. Review and update inspection and evaluation training courses annually to account for new bridge safety issues.
   b. Ensure the "take-aways" from the training are clear and concise
   c. Ensure Districts have regular meetings with inspection staff to discuss key issues
   d. Ensure team leaders and review engineers have adequate training and experience
   e. Support career path for bridge inspectors
   f. Support mentoring

2. **Objective:** Quality Control and Quality Assurance

   Strategies

   a. Develop QC and QA metrics to validate and rate program performance
   b. Ensure each District bridge inspection unit has a defined Quality Control program that is complied with.
   c. Establish QA program at the District level.
   d. Perform internal and external audits of the District's and State's bridge inspection program to ensure compliance, as necessary.
   e. Continue to perform statewide QA bridge inspection program to assess compliance with established standards and to identify areas for improvement.
   f. Review consultant QC/QA plans

3. **Objective:** Improve data collection and reporting processes

   Strategies

   a. Improve quality of inspection documentation
   b. Further implement the electronic document management system named Enterprise Content Services (ECS)
   c. Evaluate and implement inspection reporting technologies.

4. **Objective:** Responsive Organization

   Strategies

   a. Respond to state and national bridge issues in timely manner
   b. Conduct forensic investigations
   c. Respond to natural disasters affecting bridges in timely manner, Mobilize Department forces rapidly

5. **Objective:** Communication

   Strategies

   a. Maintain constant lines of communication between Districts, the Bridge Inspection Section of the Bureau of Maintenance and Operations, and the Bridge Design and Technology Division of the Bureau of Project Delivery
   b. Maintain constant lines of communication between District Bridge units and District Maintenance operations
   c. Effectively communicate the Department's bridge inspection goals and policies to other Bureaus, other bridge owners and business partners
   d. Address public concerns

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APPENDIX IP 01-B

NBIS Code of Federal Regulations (CFR)
Chapter 23 Highways – Part 650

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Publication 238 (2021 Edition), Appendix IP 01-B
NBIS Code of Federal Regulations (CFR)
Chapter 23 Highways – Part 650

JANUARY 2005 NBIS REGULATIONS,
INCLUDING DECEMBER 2009 REVISIONS

CODE OF FEDERAL REGULATIONS
PART 650--BRIDGES, STRUCTURES, AND HYDRAULICS

1. The authority citation for part 650 continues to read as follows:

Authority: 23 U.S.C. 109 (a) and (h), 144, 151, 315, and 319; 33 U.S.C. 401, 491 et eq., 511 et seq.; 23 CFR 1.32; 49 CFR 1.48(b), E.O. 11988 (3 CFR, 1977 Comp. p. 117); Department of Transportation Order 5650.2 dated April 23, 1979 (44 FR 24678); sec. 161 of Public Law 97-424, 96 Stat. 2097, 3135; sec. 4(b) of Public Law 97-134, 95 Stat. 1699; and sec. 1057 of Public Law 102-240, 105 Stat. 2002; and sec. 1311 of Pub. L. 105-178, as added by Pub. L. 105-206, 112 Stat. 842 (1998).

2. Revise subpart C to read as follows:

Subpart C--National Bridge Inspection Standards
Sec.
650.301 Purpose.
650.303 Applicability.
650.305 Definitions.
650.307 Bridge inspection organization.
650.309 Qualifications of personnel.
650.311 Inspection frequency.
650.313 Inspection procedures.
650.315 Inventory.
650.317 Reference manuals.

Subpart C--National Bridge Inspection Standards

§ 650.301 Purpose.

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

§ 650.303 Applicability.

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

§ 650.305 Definitions.

Terms used in this subpart are defined as follows:

American Association of State Highway and Transportation Officials (AASHTO) Manual. "The Manual for Bridge Evaluation," First Edition, 2008, published by the American Association of State Highway and Transportation Officials (incorporated by reference, see Sec. 650.317).

Bridge. A structure including supports erected over a depression or an obstruction, such as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads, and having an opening measured along the center of the roadway of more than 20 feet between undercopings of abutments or spring lines of arches, or extreme ends of openings for multiple boxes; it may also include multiple pipes, where the clear distance between openings is less than half of the smaller contiguous opening.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Quality assurance (QA). The use of sampling and other measures to assure the adequacy of quality control procedures in order to verify or measure the quality level of the entire bridge inspection and load rating program.

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

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

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

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

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

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

State transportation department. The term "State transportation department" is defined in 23 U.S.C. 101(a)(34).

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

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

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

§ 650.307 Bridge inspection organization.

(a) Each State transportation department must inspect, or cause to be inspected, all highway bridges located on public roads that are fully or partially located within the State's boundaries, except for bridges that are owned by Federal agencies.
(b) Federal agencies must inspect, or cause to be inspected, all highway bridges located on public roads that are fully or partially located within the respective agency responsibility or jurisdiction.
(c) Each State transportation department or Federal agency must include a bridge inspection organization that is responsible for the following:
  (1) Statewide or Federal agency wide bridge inspection policies and procedures, quality assurance and quality control, and preparation and maintenance of a bridge inventory.
  (2) Bridge inspections, reports, load ratings and other requirements of these standards.
(d) Functions identified in paragraphs (c)(1) and (2) of this section may be delegated, but such delegation does not relieve the State transportation department or Federal agency of any of its responsibilities under this subpart.
(e) The State transportation department or Federal agency bridge inspection organization must have a program manager with the qualifications defined in § 650.309(a), who has been delegated responsibility for paragraphs (c)(1) and (2) of this section.

§ 650.309 Qualifications of personnel.

(a) A program manager must, at a minimum:
  (1) Be a registered professional engineer, or have ten years bridge inspection experience; and
  (2) Successfully complete a Federal Highway Administration (FHWA) approved comprehensive bridge inspection training course.
(b) There are five ways to qualify as a team leader. A team leader must, at a minimum:
  (1) Have the qualifications specified in paragraph (a) of this section; or
  (2) Have five years bridge inspection experience and have successfully completed an FHWA approved comprehensive bridge inspection training course; or
  (3) Be certified as a Level III or IV Bridge Safety Inspector under the National Society of Professional Engineer's program for National Certification in Engineering Technologies (NICET) and have successfully completed an FHWA approved comprehensive bridge inspection training course, or
  (4) Have all of the following:
    (i) A bachelor's degree in engineering from a college or university accredited by or determined as substantially equivalent by the Accreditation Board for Engineering and Technology;
    (ii) Successfully passed the National Council of Examiners for Engineering and Surveying Fundamentals of Engineering examination;
    (iii) Two years of bridge inspection experience; and
    (iv) Successfully completed an FHWA approved comprehensive bridge inspection training course, or
  (5) Have all of the following:
    (i) An associate's degree in engineering or engineering technology from a college or university accredited by or determined as substantially equivalent by the Accreditation Board for Engineering and Technology;
    (ii) Four years of bridge inspection experience; and
    (iii) Successfully completed an FHWA approved comprehensive bridge inspection training course.
(c) The individual charged with the overall responsibility for load rating bridges must be a registered professional engineer.
(d) An underwater bridge inspection diver must complete an FHWA approved comprehensive bridge inspection training course or other FHWA approved underwater diver bridge inspection training course.

§ 650.311 Inspection frequency.

(a) Routine inspections.
  (1) Inspect each bridge at regular intervals not to exceed twenty-four months.
  (2) Certain bridges require inspection at less than twenty-four-month intervals. Establish criteria to determine the level and frequency to which these bridges are inspected considering such factors as age, traffic characteristics, and known deficiencies.
  (3) Certain bridges may be inspected at greater than twenty-four-month intervals, not to exceed forty-eight-months, with written FHWA approval. This may be appropriate when past inspection findings and analysis justifies the increased inspection interval.

(b) Underwater inspections.
  (1) Inspect underwater structural elements at regular intervals not to exceed sixty months.
  (2) Certain underwater structural elements require inspection at less than sixty-month intervals. Establish criteria to determine the level and frequency to which these members are inspected considering such factors as construction material, environment, age, scour characteristics, condition rating from past inspections and known deficiencies.
  (3) Certain underwater structural elements may be inspected at greater than sixty-month intervals, not to exceed seventy-two months, with written FHWA approval. This may be appropriate when past inspection findings and analysis justifies the increased inspection interval.

(c) Fracture critical member (FCM) inspections.
  (1) Inspect FCMs at intervals not to exceed twenty-four months.
  (2) Certain FCMs require inspection at less than twenty-four-month intervals. Establish criteria to determine the level and frequency to which these members are inspected considering such factors as age, traffic characteristics, and known deficiencies.

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

§ 650.313 Inspection procedures.

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

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

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

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

(e) Identify bridges with FCMs, bridges requiring underwater inspection, and bridges that are scour critical.
  (1) Bridges with fracture critical members. In the inspection records, identify the location of FCMs and describe the FCM inspection frequency and procedures. Inspect FCMs according to these procedures.
  (2) Bridges requiring underwater inspections. Identify the location of underwater elements and include a description of the underwater elements, the inspection frequency and the procedures in the inspection records for each bridge requiring underwater inspection. Inspect those elements requiring underwater inspections according to these procedures.
  (3) Bridges that are scour critical. Prepare a plan of action to monitor known and potential deficiencies and to address critical findings. Monitor bridges that are scour critical in accordance with the plan.

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

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

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

§ 650.315 Inventory.

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

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

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

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

§ 650.317 Reference manuals.

(a) The materials listed in this subpart are incorporated by reference in the corresponding sections noted. These incorporations by reference were approved by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. These materials are incorporated as they exist on the date of the approval, and notice of any change in these documents will be published in the **Federal Register**. The materials are available for purchase at the address listed below, and are available for inspection at the National Archives and Records Administration (NARA). These materials may also be reviewed at the Department of Transportation Library, 1200 New Jersey Avenue, SE., Washington, DC, 20590, (202) 366-0761. For information on the availability of these materials at NARA call (202) 741-6030, or go to the following URL: http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.htm In the event there is a conflict between the standards in this subpart and any of these materials, the standards in this subpart will apply.

(b) The following materials are available for purchase from the American Association of State Highway and Transportation Officials, Suite 249, 444 N. Capitol Street, NW., Washington, DC 20001, (202) 624-5800. The materials may also be ordered via the AASHTO bookstore located at the following URL: http://www.transportation.org.
   (1) The Manual for Bridge Evaluation, First Edition, 2008, AASHTO, incorporation by reference approved for § § 650.305 and 650.313.
   (2) [Reserved]

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

APPENDIX IP 01-C

NTIS Code of Federal Regulations (CFR)
Chapter 23 Highways – Part 650

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JULY 2015 NTIS REGULATIONS

CODE OF FEDERAL REGULATIONS
PART 650-BRIDGES, STRUCTURES, AND HYDRAULICS

1. The authority citation for part 650 is revised to read as follows:

Authority: 23 U.S.C. 119, 144, and 315.

2. Add subpart E to read as follows:

Subpart E-National Tunnel Inspection Standards
Sec.
650.501 Purpose.
650.503 Applicability.
650.505 Definitions.
650.507 Tunnel inspection organization responsibilities.
650.509 Qualifications of personnel.
650.511 Inspection interval.
650.513 Inspection procedures.
650.515 Inventory.
650.517 Incorporation by reference.

Subpart E-National Tunnel Inspection Standards

§ 650.501 Purpose.

This subpart sets the national minimum standards for the proper safety inspection and evaluation of all highway tunnels in accordance with 23 U.S.C. 144(h) and the requirements for preparing and maintaining an inventory in accordance with 23 U.S.C. 144(b).

§ 650.503 Applicability.

The National Tunnel Inspection Standards (NTIS) in this subpart apply to all structures defined as highway tunnels on all public roads, on and off Federal-aid Highways, including tribally and federally owned tunnels.

§ 650.505 Definitions.

The following terms used in this subpart are defined as follows:

American Association of State Highway and Transportation Officials (AASHTO) Manual for Bridge Evaluation. The term "AASHTO Manual for Bridge Evaluation" means the "Manual for Bridge Evaluation", incorporated by reference in § 650.517.

At-grade roadway. The term "at-grade roadway" means paved or unpaved travel ways within the tunnel that carry vehicular traffic and are not suspended or supported by a structural system.

Bridge inspection experience. The term "bridge inspection experience" has the same meaning as in § 650.305.

Complex tunnel. The term "complex tunnel" means a tunnel characterized by advanced or unique structural elements or functional systems.

Comprehensive tunnel inspection training. The term "comprehensive tunnel inspection training" means the FHWA-approved training that covers all aspects of tunnel inspection and enables inspectors to relate conditions observed in a tunnel to established criteria.

Critical finding. The term "critical finding" has the same meaning as in § 650.305.

Damage inspection. The term "damage inspection" has the same meaning as in § 650.305.

End-of-course assessment. The term "end-of-course assessment" means a comprehensive examination given to students after the completion of a training course.

Federal-aid highway. The term "Federal-aid highway" has the same meaning as in 23 U.S.C. 101(a)(5).

Functional systems. The term "functional systems" means nonstructural systems, such as electrical, mechanical, fire suppression, ventilation, lighting, communications, monitoring, drainage, traffic signals, emergency response (including egress, refuge room spacing, or carbon monoxide detection), or traffic safety components.

Hands-on inspection. The term "hands-on inspection" has the same meaning as in § 650.305.

Highway. The term "highway" has the same meaning as in 23 U.S.C. 101(a)(11).

In-depth inspection. The term "in-depth inspection" means a close-up inspection of one, several, or all tunnel structural elements or functional systems to identify any deficiencies not readily detectable using routine inspection procedures. In-depth inspections may occur more or less frequently than routine inspections, as outlined in the tunnel-specific inspection procedures.

Initial inspection. The term "initial inspection" means the first inspection of a tunnel to provide all inventory, appraisal, and other data necessary to determine the baseline condition of the structural elements and functional systems.

Inspection Date. The term "Inspection Date" means the date established by the Program Manager on which a regularly scheduled routine inspection begins for a tunnel.

Legal load. The terms "legal load" means the maximum legal load for each vehicle configuration permitted by law for the State in which the tunnel is located.

Load rating. The term "load rating" means the determination of the safe vehicular live load carrying capacity within or above the tunnel using structural plans, and information gathered from an inspection. The results of the load rating may include the need for load posting.

Operating rating. The term "operating rating" has the same meaning as in § 650.305.

Portal. The term "portal" means the entrance and exit of the tunnel exposed to the environment; portals may include bare rock, constructed tunnel entrance structures, or buildings.

Procedures. The term "procedures" means the written documentation of policies, methods, considerations, criteria, and other conditions that direct the actions of personnel so that a desired end result is achieved consistently.

Professional Engineer (P.E.). The term "Professional Engineer (P.E.)" means an individual who has fulfilled education and experience requirements and passed examinations that, under State licensure laws, permits the individual to offer engineering services within areas of expertise directly to the public.

Program Manager. The term "Program Manager" means the individual in charge of the inspection program who has been assigned or delegated the duties and responsibilities for tunnel inspection, reporting, and inventory. The Program Manager provides overall leadership and guidance to inspection Team Leaders and load raters.

Public road. The term "public road" has the same meaning as in 23 U.S.C. 101(a)(21).

Quality assurance (QA). The term "quality assurance (QA)" means the use of sampling and other measures to ensure the adequacy of quality control procedures in order to verify or measure the quality of the entire tunnel inspection and load rating program.

Quality control (QC). The term "quality control (QC)" means the procedures that are intended to maintain the quality of a tunnel inspection and load rating at or above a specified level.

Routine inspection. The term "routine inspection" means a regularly scheduled comprehensive inspection encompassing all tunnel structural elements and functional systems and consisting of observations and measurements needed to determine the physical and functional condition of the tunnel, to identify any changes from initial or previously recorded conditions, and to ensure that tunnel components continue to satisfy present service requirements.

Routine permit load. The term "routine permit load" means a vehicular load that has a gross weight, axle weight, or distance between axles not conforming with State laws for legally configured vehicles, and is authorized for unlimited trips over an extended period of time to move alongside other heavy vehicles on a regular basis.

Special inspection. The term "special inspection" means an inspection, scheduled at the discretion of the tunnel owner, used to monitor a particular known or suspected deficiency.

State transportation department (State DOT). The term "State transportation department (State DOT)" has the same meaning as in 23 U.S.C. 101(a)(28).

Team Leader. The term "Team Leader" means the on-site individual in charge of an inspection team responsible for planning, preparing, performing, and reporting on tunnel inspections.

Tunnel. The term "tunnel" means an enclosed roadway for motor vehicle traffic with vehicle access limited to portals, regardless of type of structure or method of construction, that requires, based on the owner's determination, special design considerations that may include lighting, ventilation, fire protection systems, and emergency egress capacity. The terms "tunnel" does not include bridges or culverts inspected under the National Bridge Inspection Standards (subpart C of this part).

Tunnel inspection experience. The term "tunnel inspection experience" means active participation in the performance of tunnel inspections in accordance with the National Tunnel Inspection Standards, in either a field inspection, supervisory, or management role.

Tunnel inspection refresher training. The term "tunnel inspection refresher training" means an FHWA-approved training course that aims to improve the quality of tunnel inspections, introduce new techniques, and maintain the consistency of the tunnel inspection program.

Tunnel Operations, Maintenance, Inspection and Evaluation (TOMIE} Manual. The term "Tunnel Operations, Maintenance, Inspection and Evaluation (TOMIE) Manual" means the "Tunnel Operations, Maintenance, Inspection and Evaluation (TOMIE) Manual" (incorporated by reference, see § 650.517).

Tunnel-specific inspection procedures. The term "tunnel-specific inspection procedures" means the written documentation of the directions necessary to plan for, and conduct an inspection. Directions include coverage of inspection methods, frequency of each method, inspection equipment, access equipment, identification of tunnel elements, components and functional systems, traffic coordination, and specialized qualifications for inspecting personnel.

§ 650.507 Tunnel inspection organization responsibilities.

(a) Each State DOT shall inspect, or cause to be inspected, all highway tunnels located on public roads, on and off Federal-aid highways, that are fully or partially located within the State's boundaries, except for tunnels that are owned by Federal agencies or tribal governments.
(b) Each Federal agency shall inspect, or cause to be inspected, all highway tunnels located on public roads, on and off Federal-aid highways, that are fully or partially located within the respective agency's responsibility or jurisdiction.
(c) Each tribal government shall inspect, or cause to be inspected, all highway tunnels located on public roads, on and off Federal-aid highways, that are fully or partially located within the respective tribal government's responsibility or jurisdiction.
(d) Where a tunnel is jointly owned, all bordering States, Federal agencies, and tribal governments with ownership interests should determine through a joint formal written agreement the inspection responsibilities of each State, Federal agency, and tribal government.
(e) Each State that contains one or more tunnels subject to these regulations, or Federal agency or tribal government with a tunnel under its jurisdiction, shall include a tunnel inspection organization that is responsible for all of the following:
    (1) Statewide, Federal agency-wide, or tribal government-wide tunnel inspection policies and procedures (both general and tunnel-specific), quality control and quality assurance procedures, and preparation and maintenance of a tunnel inventory.
    (2) Tunnel inspections, written reports, load ratings, management of critical findings, and other requirements of these standards.
    (3) Maintaining a registry of nationally certified tunnel inspectors that work in their State or for their Federal agency or tribal government that includes, at a minimum, a method to positively identify each inspector, documentation that the inspector's training requirements are up-to-date, the inspector's current contact information, and detailed information about any adverse action that may affect the good standing of the inspector.
    (4) A process, developed under the direction of a Professional Engineer and approved by FHWA, to determine when an inspection Team Leader's qualifications must meet §650.509(b)(4) in order to adequately and appropriately lead an inspection of a complex tunnel or a tunnel with distinctive features or functions. At a minimum, the process shall consider a tunnel's type of construction, functional systems, history of performance, and physical and operational conditions.
(f) A State DOT, Federal agency, or tribal government may delegate functions identified in paragraphs (e)(1), (2), and (3) of this section through a formal written agreement, but such delegation does not relieve the State DOT, Federal agency, or tribal government of any of its responsibilities under this subpart.
(g) The State DOT, Federal agency, or tribal government tunnel inspection organization shall have a Program Manager with the qualifications listed in § 650.509(a), who has been delegated responsibility for paragraphs (e)(1), (2), and (3) of this section.

§ 650.509 Qualifications of personnel.

(a) A program manager shall, at a minimum:
    (1) Be a registered Professional Engineer, or have 10 years of tunnel or bridge inspection experience;
    (2) Be a nationally certified tunnel inspector;
    (3) Satisfy the requirements of paragraphs (a)(1) and (2) of this section by August 31, 2017; and
    (4) Be able to determine when a Team Leader's qualifications must meet the requirements of paragraph (b)(1)(i) of this section in accordance with the FHWA approved process developed in accordance with §650.507(e)(4).
(b) A Team Leader shall, at a minimum:
    (1) Meet at least one of the four qualifications listed in paragraphs (b)(1)(i) through (iv) of this section:
        (i) Be a registered professional engineer and have six months of tunnel of bridge inspection experience.
        (ii) Have 5 years of tunnel or bridge inspection experience.

(iii) Have all of the following:
(A) A bachelor's degree in engineering or engineering technology from a college or university accredited or determined as substantially equivalent by the Accreditation Board for Engineering and Technology.
(B) Successfully passed the National Council of Examiners for Engineering and Surveying Fundamentals of Engineering examination.
(C) Two (2) years of tunnel or bridge inspection experience.
(iv) Have all of the following:
(A) An associate's degree in engineering or engineering technology from a college or university accredited or determined as substantially equivalent by the Accreditation Board for Engineering and Technology.
(B) Four years of tunnel or bridge inspection experience.
(2) Be a nationally certified tunnel inspector.
(3) Provide documentation supporting the satisfaction of paragraphs (b)(1) and (2) of this section to the Program Manager of each State DOT, Federal agency, or tribal government for which they are performing tunnel inspections.
(4) Be a registered Professional Engineer and have six months of tunnel or bridge inspection experience if the Program Manager determines through the approved process developed under § 650.507(e)(4) that the tunnel being inspected is complex or has distinctive features or functions that warrant this level of qualifications.
(c) Load ratings shall be performed by, or under the direct supervision of, a registered Professional Engineer.
(d) Each State DOT, Federal agency, and tribal government shall determine inspection personnel qualifications for damage, cursory, and special inspections.
(e) A nationally certified tunnel inspector shall:
(1) Complete an FHWA-approved comprehensive tunnel inspection training course and score 70 percent or greater on an end-of-course assessment;
(2) Complete a cumulative total of 18 hours of FHWA-approved tunnel inspection refresher training over each 60-month period; and
(3) Maintain documentation supporting the satisfaction of paragraphs (e)(1) and (2) of this section, and, upon request, provide documentation of their training status and current contact information to the Tunnel Inspection Organization of each State DOT, Federal agency, or tribal government for which they will be performing tunnel inspections.
(f) Acceptable tunnel inspection training includes the following:
(1) *National Highway Institute training.* NHI courses on comprehensive tunnel inspection training.
(2) *FHWA approval of alternate training.* A State DOT, Federal agency, or tribal government may submit to FHWA a training course as an alternative to the NHI course. The FHWA shall approve alternative course materials and end-of-course assessments for national consistency and certification purposes. The Program Manager shall review the approved alternative training course every 5 years to ensure the material is current. Updates to approved course materials and end-of-course assessments shall be resubmitted to FHWA for approval.
(g) In evaluating the tunnel inspection experience requirements under paragraphs (a) and (b) of this section, a combination of tunnel design, tunnel maintenance, tunnel construction, and tunnel inspection experience, with the predominant amount in tunnel inspection, is acceptable. Also, the following criteria should be considered:
(1) The relevance of the individual's actual experience, including the extent to which the experience has enabled the individual to develop the skills needed to properly lead a tunnel safety inspection.
(2) The individual's exposure to the problems or deficiencies common in the types of tunnels being inspected by the individual.
(3) The individual's understanding of the specific data collection needs and requirements.

§ 650.511 Inspection interval.

(a) *Initial inspection.* A State DOT, Federal agency, or tribal government tunnel inspection organization shall conduct, or cause to be conducted, an initial inspection for each tunnel described in § 650. 503 as follows:

(1) For existing tunnels, conduct a routine inspection of each tunnel according to the inspection guidance provided in the Tunnel Operations, Maintenance, Inspection and Evaluation (TOMIE) Manual (incorporated by reference, *see* § 650.517) by August 13, 2017.

(2) For tunnels completed after these regulations take effect, the initial routine inspection shall be conducted after all construction is completed and prior to opening to traffic, according to the inspection guidance provided in the Tunnel Operations, Maintenance, Inspection and Evaluation (TOMIE) Manual (incorporated by reference, *see* §650.517).

(b) *Routine inspections.* A State DOT, Federal agency, or tribal government tunnel inspection organization shall conduct, or cause to be conducted, routine inspections for each tunnel described in § 650.503 as follows:

(1) Establish for each tunnel the NTIS routine Inspection Date in a month and year (MM/DD/YYYY) format. This date should only be modified by the Program Manager in rare circumstances.

(2) Inspect each tunnel at regular 24-month intervals.

(3) For tunnels needing inspection more frequently than 24-month intervals, establish criteria to determine the level and frequency to which these tunnels are inspected, based on a risk analysis approach that considers such factors as tunnel age, traffic characteristics, geotechnical conditions, and known deficiencies.

(4) Certain tunnels may be inspected at regular intervals up to 48 months. Inspecting a tunnel at an increased interval may be appropriate when past inspection findings and analysis justifies the increased inspection interval. At a minimum, the following criteria shall be used to determine the level and frequency of inspection based on an assessed lower risk: Tunnel age, time from last major rehabilitation, tunnel complexity, traffic characteristics, geotechnical conditions, functional systems, and known deficiencies. A written request that justifies a regular routine inspection interval between 24 and 48 months shall be submitted to FHWA for review and comment prior to the extended interval being implemented.

(5) Inspect each tunnel in accordance with the established interval. The acceptable tolerance for inspection interval is within 2 months before or after the Inspection Date established in paragraph (b)(1) of this section in order to maintain that date. The actual month, day, and year of the inspection are to be reported in the National Tunnel Inventory.

(c) Damage, in-depth, and special inspections. The Program Manager shall establish criteria to determine the level and frequency of damage, in-depth, and special inspections. Damage, in-depth, and special inspections may use nondestructive testing or other methods not used during routine inspections at an interval established by the Program Manager. In-depth inspections should be scheduled for complex tunnels and for certain structural elements and functional systems when necessary to fully ascertain the condition of the element or system; hands-on inspection may be necessary at some locations.

§ 650.513 Inspection procedures.

Each State DOT, Federal agency, or tribal government tunnel inspection organization, to carry out its inspection responsibilities, shall perform or cause to be performed all of the following:

(a) Inspect tunnel structural elements and functional systems in accordance with the inspection guidance provided in the Tunnel Operations, Maintenance, Inspection and Evaluation (TOMIE) Manual (incorporated by reference, *see* § 650.517).

(b) Provide at least one Team Leader, who meets the minimum qualifications stated in § 650.509, at the tunnel at all times during each initial, routine, and in-depth inspection. The State DOT, Federal agency, or tribal government shall report the nationally certified tunnel inspector identification for each Team Leader that is wholly or partly responsible for a tunnel inspection must be reported to the National Tunnel Inventory.

(c) Prepare and document tunnel-specific inspection procedures for each tunnel inspected and inventoried that shall:

(1) Take into account the design assumptions and the tunnel complexity; and

(2) Identify the –

(i) Tunnel structural elements and functional systems to be inspected;
(ii) Methods of inspection to be used;
(iii) Frequency of inspection for each method; and
(iv) Inspection equipment, access equipment, and traffic coordination needed.

(d) Establish requirements for functional system testing, direct observation of critical system checks, and testing documentation.

(e) For complex tunnels, identify specialized inspection procedures and additional inspector training and experience required to inspect complex tunnels. Inspect complex tunnels according to the specialized inspection procedures.

(f) Conduct tunnel inspections with qualified staff not associated with the operation or maintenance of the tunnel structure or functional systems.

(g) Rate each tunnel's safe vehicular load-carrying capacity in accordance with the Sections 6 or 8, AASHTO Manual for Bridge Evaluation (incorporated by reference, *see* § 650.517). A State DOT, Federal agency, or tribal government shall conduct a load rating evaluation as soon as practical, but not later than three months after the completion of the inspection, if a change in condition is identified. Post or restrict the highways in or over the tunnel in accordance with Section 6, AASHTO Manual for Bridge Evaluation (incorporated by reference, *see* § 650.517), or in accordance with State law, when the maximum unrestricted legal loads or State routine permit loads exceed those allowed under the operating rating or equivalent rating factor. Postings shall be made as soon as possible but not later than 30 days after a valid load rating determines a need for such posting. At-grade roadways in tunnels are exempt from load rating. A State DOT, Federal agency, or tribal government, shall maintain load rating calculations or input files with a summary of results as a part of the tunnel record.

(h) Prepare tunnel inspection documentation as described in the Tunnel Operations, Maintenance, Inspection and Evaluation (TOMIE) Manual (incorporated by reference, *see* § 650.517), and maintain written reports or electronic files on the results of tunnel 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 tunnel condition. At a minimum, information collected will include data regarding basic tunnel information (e.g., tunnel location, posted speed, inspection reports, repair recommendations, and repair and rehabilitation work completed), tunnel and roadway geometrics, interior tunnel structural features, portal structure features, and tunnel systems information. When available, tunnel data collected shall include diagrams, photos, condition of each structural and functional system component, notations of any action taken to address the findings of such inspections, and the national tunnel inspector certification registry identification for each Team Leader responsible in whole or in part for the inspection.

(i) Use systematic quality control and quality assurance procedures to maintain a high degree of accuracy and consistency in the inspection program. Include periodic field review of inspection teams, data quality checks, and independent review of inspection reports and computations.

(j) Establish a Statewide, Federal agency-wide, or tribal government-wide procedure to ensure that critical findings are addressed in a timely manner. Notify FHWA within 24 hours of any critical finding and the activities taken, underway, or planned to resolve or monitor the critical finding. Update FHWA regularly or as requested on the status of each critical finding until it is resolved. Annually provide a written report to FHWA with a summary of the current status of the resolutions for each critical finding identified within that year or unresolved from a previous year.

(k) Provide information at least annually, or more frequently upon request, in cooperation with any FHWA review of State DOT, Federal agency, or tribal government compliance with the NTIS. The FHWA will assess annually State DOT compliance using statistical assessments and well-defined measures based on the requirements of this subpart.

§ 650.515 Inventory.

(a) *Preliminary inventory.* Each State, Federal agency, or tribal government shall collect and submit the inventory data items described in the Specifications for the National Tunnel Inventory (incorporated by reference, *see* § 650.517) for all tunnels subject to the NTIS by December 11, 2015.

(b) *National Tunnel Inventory.* Each State, Federal agency, or tribal government shall prepare, maintain, and make available to FHWA upon request, an inventory of all highway tunnels subject to the NTIS that includes the preliminary inventory information submitted in paragraph (a) of this section, reflects the findings of the most recent tunnel inspection conducted, and is consistent and coordinated with the Specifications for the National Tunnel Inventory.

(c) *Data entry for inspections.* For all inspections, each State DOT, Federal agency, or tribal government shall enter the appropriate tunnel inspection data into its inventory within 3 months after the completion of the inspection.

(d) *Data entry for tunnel modifications and new tunnels.* For modifications to existing tunnels that alter previously recorded data and new tunnels, each State DOT, Federal agency, or tribal government shall enter the appropriate data into its inventory within 3 months after the completion of the work.

(e) *Data entry for tunnel load restriction and closure changes.* For changes in traffic load restriction or closure status, each State DOT, Federal agency, or tribal government shall enter the data into its inventory within 3 months after the change in status of the tunnel.

§ 650.517 Incorporation by reference.

(a) Certain material is incorporated by reference into this part with the approval of the Director of the Federal Register under 5 U.S.C. 552(a) and 1 CFR part 51. To enforce any edition other than that specified in this section, the FHWA must publish notice of change in the **Federal Register** and the material must be available to the public. All approved material is available for inspection at 1200 New Jersey Avenue SE, Washington DC 20590. For questions regarding the availability of this material at FHWA, call the FHWA Regulations Officer, Office of the Chief Council, HCC-10, 202-366-0761. This material is also available for inspection at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202-741-6030 or go to http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html.

(b) American Association of State Highway and Transportation Officials (AASHTO), Suite 249, 444 N. Capitol Street, NW., Washington, DC 20001, 800-231-3475, https://bookstore.transportation.org.
    (1) "The Manual of Bridge Evaluation," Section 6 "Load Rating" and Section 8 "Nondestructive Load Testing," Second Edition, 2011, copyright 2011, incorporation by reference approved for §§ 650.505 and 650.513(a).
    (2) 2011 Interim Revisions to "The Manual of Bridge Evaluation," Section 6 "Load Rating," Second Edition, 2010, copyright 2011, incorporation by reference approved for §§ 650.505 and 650.513(a).
    (3) 2013 Interim Revisions to "The Manual of Bridge Evaluation," Section 6 "Load Rating," Second Edition, 2010, copyright 2013, incorporation by reference approved for §§ 650.505 and 650.513(a).
    (4) 2014 Interim Revisions to "The Manual of Bridge Evaluation," Section 6 "Load Rating," Second Edition, 2010, copyright 2013, incorporation by reference approved for §§ 650.505 and 650.513(a).
    (5) 2015 Interim Revisions to "The Manual of Bridge Evaluation," Section 6 "Load Rating," Second Edition, 2010, copyright 2014, incorporation by reference approved for §§ 650.505 and 650.513(a).

(c) Office of Bridges and Structures, Federal Highway Administration, U.S. Department of Transportation, 1200 New Jersey Avenue SE., Washington, DC 20590.
    (1) FHWA-HIF-15-005, "Tunnel Operations, Maintenance, Inspection and Evaluation (TOMIE) Manual," 2015 edition, available in electronic format at http://www.fhwa.dot.gov/bridge/inspection/tunnel/. Incorporation by reference approved for§§ 650.505, 650.511(a), and 650.513(a) and (h).
    (2) FHWA-HIF-15-006, "Specifications for National Tunnel Inventory," 2015 edition, available in electronic format at http://www.fhwa.dot.gov/bridge/inspection/tunnel/. Incorporation by reference approved for § 650.515(a) and (b).

APPENDIX IP 01-D

Local NBIS Inspection Notification Letter

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pennsylvania
DEPARTMENT OF TRANSPORTATION

DATE:

SUBJECT: Inspection Notification – National Bridge Inspection Standards

TO: **LOCAL BRIDGE OWNER - TO BE COMPLETED BY DISTRICT**

FROM: **TO BE COMPLETED BY DISTRICT**

This letter addresses bridge safety inspection regarding:

- Critical Structural Deficiencies
- Scour Critical Bridges and Scour Plans of Action
- Notification of Inspection Due Dates
- Inspection Agreements with PennDOT
- Responsibility for Frequency Compliance
- Bridge Safety Inspection Reporting and Scheduling
- Bridge Posting Requirements
- Bridge Closure Reporting
- List of Bridges to be inspected

Critical Structural Deficiencies

When a critical structural deficiency that threatens to compromise public safety is identified, bridge owners are obligated to act expeditiously either to repair that deficiency or to take other actions, such as restricting or closing the bridge. A registered professional engineer will identify the critical deficiency and the required actions in the inspection report and/or in a separate critical deficiency letter. In addition, the engineer is required to develop a Plan of Action (POA) to address the critical structural deficiency and schedule a meeting with the bridge owner to present details of the POA to the bridge owner. This meeting is to be held within three calendar days and must be attended by appropriate officials from **DISTRICT TO INSERT MUNICIPALITY NAME.** Immediate action may be required to mitigate any critical deficiency posing a danger to the public. Such action should not be deferred pending results of the meeting. The meeting should not be adjourned until agreement has been reached regarding specific actions to be taken, as well as a schedule for implementation. Failure to take appropriate actions for public safety may result in the Department's restricting or closing the bridge. The non-federal share of the cost incurred by the Department in undertaking such restrictions may be deducted from the local bridge owner's liquid fuels allocation in the future, pursuant to the statutory authority described in the section entitled "Notification of Inspection Due Dates".

Scour Critical Bridges and Scour Plans of Action

As required by the 2005 National Bridge Inspection Standards (NBIS), Section 650.313 (e) (3), bridge owners are required to develop a Scour Plan of Action (POA) for bridges in Scour Categories A, B, C, and D. This plan describes the required monitoring procedures and documents known critical deficiencies, as well as all needed scour protection measures for scour critical bridges. Scour critical bridges have been identified by Categories A, B and C based on the scour vulnerability of each bridge with a Category A being the most vulnerable to scour. A Scour POA document includes sections for a monitoring program and a Bridge Closure Plan when flooding of bridges is reported or observed. A Scour POA has information specific to **DISTRICT TO INSERT MUNICIPALITY NAME** including responsibilities for monitoring, closure, and contact information. The Scour POA also contains other pertinent bridge inventory data, previous scour inspection data, and completed and recommended maintenance data related to scour.

The Scour POA serves two purposes:

1. Establishes a systematic process of monitoring and closing bridges to ensure public safety during a significant flood event and criteria for re-opening and inspection after a significant flood event.
2. Assists bridge owners to program and prioritize the installation of scour countermeasures to protect scour critical bridges from flood damage.

Bridge owners must coordinate with their District Municipal Services representative to ensure that all scour critical bridges are identified, and Scour POA documents have been updated with completed sections for Monitoring Program, Bridge Closure Plan and current contact information. For informational materials pertaining to monitoring scour critical bridges during flood events, visit PennDOT's website for Local Scour Critical Bridges located at:

http://www.penndot.gov/ProjectAndPrograms/Bridges/Pages/Local-Scour-Critical-Bridge-Information.aspx

The current scour critical bridge list specific to **DISTRICT TO INSERT MUNICIPALITY NAME** is also enclosed. Maps showing the location and category of county, and municipal scour critical bridges may be accessed by going to the PennDOT Local Scour Critical Bridge Map website located at:

http://padotgis.maps.arcgis.com/apps/webappviewer/index.html?id=0f62b3249c12447082f5b3151eadfeaf

The website assists local bridge owners to identify, locate, and confirm ownership of scour critical bridges. The map is updated on a monthly basis because the scour critical category of a bridge may change based on bridge inspection findings. Clicking once on the map symbol for a bridge will provide a pop-up information box. The bridge-specific blank monitoring log can be downloaded from the link inside the pop-up box. The log, in portable document format (PDF), includes basic information for the bridge and general monitoring instructions. The monitoring log provides both a means for recording monitoring activities and is also a decision tool for determining when to close a bridge for safety. Please note that these completed monitoring logs must be filled out by the local bridge owners and kept on file for later review, if requested by FHWA.

As previously noted, bridge owners need to be aware that the Scour Critical status of bridges can change based on field conditions observed during the biennial bridge inspection. Bridge inspection files may require periodic updates to the Scour POA, or a new Scour POA must be developed for a bridge when inspection findings identify the bridge as Scour Critical. Owners should be aware that periodic updates of these Scour POA's may be required as scour conditions at the bridge change.

Notification of Inspection Due Dates

The majority of locally owned bridges in Pennsylvania are inspected on time. Municipalities and counties have formed a cooperative working relationship with the Pennsylvania Department of Transportation (PennDOT) to ensure that timely and accurate inspections occur. PennDOT, in its oversight capacity, is attempting to be more proactive in communicating with local bridge owners during the bridge inspection process. The enclosed list of bridges in **DISTRICT TO INSERT MUNICIPALITY NAME** indicates inspection due dates between April **YEAR** and March **YEAR**. The process of sending this annual letter serves as a reminder to local bridge owners, county planning agencies, engineering consultants, and PennDOT staff, in an effort to prevent bridge inspections from becoming past due.

In the event that a bridge inspection does become past due, PennDOT intends to conduct inspections on locally owned bridges during the month in which the inspection is due or within fifteen (15) days if the bridge becomes past due at the end of the month. The Department's authority to carry out the inspections is stated in Section 2002(a)(19) of the Administrative Code of 1929, as amended by Act 44 of 1988, 71 P.S. § 512(a)(19). PennDOT is issuing this advance written notice to all local bridge owners in order to adhere to a statutory requirement for a sixty-(60) day notification. PennDOT is also authorized by Act 44 of 1988 to deduct the non-reimbursed bridge inspection costs from liquid fuels allocations. This statutory authorization is found in Section 2001.5 of the Administrative Code of 1929, as amended, 71 P.S. § 511.5, which was added by Act 44 of 1988.

Inspection Agreements with PennDOT

PennDOT enters into agreements for bridge inspection with individual municipalities or with multiple municipalities under an agreement through a county or regional government body. Please confirm that the listed bridges are covered under a current agreement. If an agreement has expired, or will expire prior to the inspection due dates, please contact **INSERT NAME AND PHONE NUMBER OF LOCAL BRIDGE INSPECTION COORDINATOR.** If a pending agreement has been drafted, but not yet executed, please contact **INSERT NAME OF LOCAL BRIDGE INSPECTION COORDINATOR** to ensure that the agreements can be executed in sufficient time to conduct the bridge inspections.

Local municipal bridge owners may contract individually with a qualified engineering consultant firm or use a PennDOT countywide or district-wide (umbrella) consultant engineering agreement for municipal bridges. Regardless of whether the inspection is performed with in-house staff or from engineering consultants, all personnel performing the inspection must meet NBIS and PennDOT qualifications.

Option 1 – Owner utilizes PennDOT hired consultants:

- Using PennDOT-hired consultants in ECMS will save effort and some cost since:
  - PennDOT manages the inspections thus avoiding the local owner's administrative staff effort in reviewing statements of interest, selecting and performing the contractual execution for the consultant inspection firm(s).
  - No initial inspection cost incurred by the local owner, thus no administrative effort required to review invoices submitted by inspection consultant. PennDOT handles the reimbursement requirements to the consultant firms through ECMS.
  - PennDOT will automatically withhold the non-reimbursable local share (20%) from the municipality's liquid fuels allocations in the fiscal year following the inspection. This will benefit the local owner in one, not having to budget 100% of the costs upfront and seeking the 80% reimbursement along with associated administrative efforts and costs and two, the 20% comes out of the following fiscal year prior to issuing the total liquid fuels amount for that municipality.

Option 2 -Owner contracts individually with a qualified engineering consultant firm:

- Per PennDOT's Local Project Delivery Manual (PennDOT Publication 740) all new third-party engineering agreements for local projects are required to use ECMS. The use of ECMS for consultant selection and executing engineering agreements should result in time and cost savings for the local project sponsors.
- The procedure is as follows:
  - Owner hires a qualified engineering firm through a qualification-based selection process and enters into an Engineering Agreement. The owner is responsible for management of the agreement.
  - Owner pays 100% of the cost of the inspections to the engineering firm directly.
  - Owner is reimbursed 80% of the costs through a Reimbursement Agreement with PennDOT.

<u>Responsibility for Frequency Compliance</u>

The following bridge inspection program activities are assigned in PennDOT's Publication 238, Bridge Safety Inspection Manual:

- Federal Highway Administration (FHWA) – Verify the National Bridge Inspection Standard (NBIS) compliance for all states.
- PennDOT Bureau of Maintenance and Operations – Collect and compile all bridge inventory and inspection data for all public roads in Pennsylvania.

- PennDOT Engineering Districts – NBIS compliance for all bridges in the District's jurisdiction.
- Local Bridge Owner – Inspecting and rating of all bridges (by in-house staff or by consultant). Provide inspection reports to PennDOT.

Collectively, all parties have a role to make certain that timely inspections occur for all highway bridges in Pennsylvania. NBIS is set forth in the 23 CFR Part 650 which states in §650.311:

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

Typically, inspections for individual bridges occur within the same calendar month for each inspection cycle. The field inspection for a bridge is considered to be past due if it has not been completed by the last day of the scheduled calendar month. This also applies to bridges that are inspected more frequently than the twenty-four month cycle.

Bridge Safety Inspection Reporting and Scheduling

Inspections must be accompanied by timely reports submitted to the Department for review. PennDOT's Publication 238, Bridge Safety Inspection Manual, requires that draft inspection reports are due within four weeks after the field inspection has been completed. Particular emphasis needs to be placed on submission of the draft inspection report to facilitate review and comment prior to acceptance of the final report. This ensures the Department's Bridge Management System (BMS2) is updated within timeframes specified by NBIS.

The current inspection date, frequency, and scheduling for each bridge can be found in BMS2; it is accessible via the internet to local bridge owners and/or their consultants who have registered as a Business Partner with PennDOT. This specific information is found on the Ratings & Schedule link in fields 7A01 and 7A09, respectively. The information in field 7A10, Next Dt - Next Inspection Date, does not automatically update; therefore, the "Next Inspection Date Calculation" button must be clicked in order to update the information. In order for the date to calculate correctly, the frequency located in 7A09 must be verified for accuracy.

Bridge Posting Requirements

PennDOT is required by the Pennsylvania Consolidated Statutes Title 75 Vehicles, Chapter 49 Size, Weight and Load Restrictions and Act 44 of 1988, 71 P.S. § 512(a)(19) to ensure compliance of all Municipal and County owned bridges with regards to bridge load postings.

Once a bridge load posting has been recommended the bridge owner is to implement the posting in accordance with PennDOT Department Policy. The bridge owner shall notify the local PennDOT District Bridge Inspection Staff once the load posting has been implemented.

Also, all pertinent BMS2 data fields shall be updated accordingly by the bridge owner or their inspection engineer.

If it is determined that the bridge load posting has not been implemented according to Department Policy, PennDOT shall notify in writing the bridge owner immediately that the Department intends to implement a bridge posting. The Department shall invoice the bridge owner for all non-reimbursed costs associated with the bridge posting implementation.

Bridge Closure Reporting

After notifying the internal agency staff upon closure of a bridge, bridge owner should notify PennDOT Local District Office Bridge Inspection Section staff regardless of reason for closure after the closure is safely and securely in place. The notification should include the Bridge Management System (BMS) number or bridge name and the reason for closure. This notification coincides with Bureau of Maintenance and Operations efforts to gather the most up to date information for all of the bridges meeting the NBIS requirements and will allow for more efficient planning of bridge inspection resources as may arise.

List of Bridges to be Inspected

As discussed above, an enclosed list indicates the bridges within **DISTRICT TO INSERT MUNICIPALITY OR COUNTY NAME** and their respective inspection due dates. A second enclosed list of Scour Critical bridges identifies the Scour Critical category for each structure and indicates whether or not a Scour POA is on file. A copy of this letter and bridge lists are also being forwarded to **DISTRICT TO INSERT APPLICABLE COUNTY/REGION PLANNING AGENCY** and/or **LOCAL BRIDGE CONSULTING ENGINEER.**

Should you require any additional information, please contact, **TO BE COMPLETED BY DISTRICTS.**

Encl: List of Bridges to be Inspected
Scour Critical Bridge List

cc: County/Region Planning Agency (as applicable)
Designated Consulting Engineer (as applicable)
District Municipal Services Supervisor

Attachment – List of Bridges to be Inspected

Attachment – Scour Critical Bridge List

APPENDIX IP 01-E

BMS2 Inventory Items Eligible for Right-to-Know Law

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Publication 238 (2021 Edition), Appendix IP 01-E
BMS2 Inventory Items Eligible for Right-to-Know Law

The following list of BMS2 Items is inventory in nature. In accordance with Publication 238 Section IP 1.8.2, the below listed items may be released to the public upon request. For requests for any other bridge or structure related data, see Publication 238 Section IP 1.8 for further instructions on the Right-to-Know Law (RTKL).

The following table identifies BMS2 Inventory Items that may be released to the public upon request:

List of BMS2 Inventory Information Items			
BMS2 ITEM	Item Description	BMS2 ITEM	Item Description
5A01	Structure Identification Number	FT, FR, FW	Features Intersected Reference
6A01	State Senatorial District	6C02/6C03	State Route & Segment Designation
6A02	US Congressional District	5C01	Feature Description
6A03	Legislative District	5C03	Bridge Feature On/Under Indicator
5A12	Name of Border State Code	5C06	Traffic Route Number
5A12	Percentage of Deck Area of Border State	5C06	Traffic Direction
5A13	Border Bridge Structure Number	5C04	Route Signing Prefix
6A06	Agency Submitting Inventory Record	5C05	Designated Level of Service
5A02/5A09	Structure Name/Location of Structure	5B09	Bridge Skew Angle
5A10	Latitude of Bridge Location	6C26	Bridge Median Width
5A11	Longitude of Bridge Location	FR07	Number of Through Lanes of Railroad Tracks
5A06	Local County Subdivision Code	FR06	Number of Electrified Railroad Tracks
6A04	County or Municipal Boundary Bridge	FR03	Service Status of Railroad
6A07	Federal Funding Code	FR05	Association of American Railroads ID Number
VN01	Design Exception	FR04	Railroad Milepoint
VM05	PSU-PUC Docket Number	6C05	Highway Administration Jurisdiction Coding
VN05	Design Drawing Number	6C10	Highway System Coding
VN06	Shop Drawing Number	5C29	National Highway System Coding
5A15/VW13	Year the Bridge was Built	5C22	Functional Classification Coding
5A16/VW14	Year of Last Major Reconstruction	6C11	State Highway Network Coding
5C30	School Bus Route Indicator	5C33	National Truck Network Coding
5C32	Public Transportation Indicator	4A20	Minimum Lateral Underclearance (Lt & Rt)
5A21	Owner or Principal Custodian	6C19	Total Horiz. Clearance for Roadways (Lt & Rt)
VM01	Legislative Act No. of Ownership Transfer	6C21	Min. Vert. Clearance for Roadways (Lt & Rt)
VM02/VW34	Maintenance Responsibility	6C23	Vert. Clear. Over 10 Ft. Width (Defense Hwy)
VM03/VM04	Maintenance Responsibility Code	5C28	Defense Highway Designation
5C21	Toll Facility Indicator	5C10	Average Daily Traffic Count
5A17/5A18	Type of Service	5C11	Average Daily Traffic Count Year
5E03	Temporary Structure Indicator	6C27	Average Daily Traffic Truck Count
5C07	Critical Facility Indicator	6C28	Average Daily Traffic Truck Count Year
6A43	Approach Pavement Width	5C14	Average Daily Traffic Truck Count (percent)
5C26	Approach Roadway Width	6C24	Vertical Clearance Signing
5C27	Bridge Roadway Width – Curb to Curb	5A07	FHWA Features Intersected
5B10	Flared Bridge Width Indicator	5A08	FHWA Facility Carried by the Structure
5B07	Bridge Deck Width – Out to Out	5C08	Total Lanes On/Under the Structure
5B05/5B06, VI05/VI06	Sidewalk Types and Widths		
5C15	Bypass Detour Length		
VI09/VI10	Horizontal or Vertical Curve Indicator		
5A14	FIPS Code		

BMS2 Inventory Items Eligible for Right-to-Know Law

List of BMS2 Inventory Information Items			
BMS2 ITEM	Item Description	BMS2 ITEM	Item Description
5E04	Historical Significance Indicator	Not Used	Utility Occupancy Reference Number
6A11	Covered Bridge Indicator	FT01/FT06	Name & Address of Utility Company
6A53	Est. Cumulative Truck Traffic for Fatigue	FT03	License Number of Utility Company (s)
4B01	Design Load	FT04	Utility License – Date issued
VD01	Design Method	FT05	Total Weight of Utility
5A	Structure Config. & Matl. – Main & Approach	FW01	Name of Stream
6A	FHWA Code for Structural Conf. & Matl.	FW07	Drainage Area of Stream
VD19	Length of Culvert Barrel	FW11	Vertical Clearance – Streambed to Structure
5B20	Total Length of the Structure	FW14-17	Design Flood – Magn., Freq., Elev., Vel.
5E01	NBIS Bridge Length Indicator	FW12/FW13	Max. Water Surface Elevation & Year
5B17	Maximum Span Length	FW08	Fishable Stream Indicator
6A38	Bridge Deck Type	4A24	Navigational Control Indicators
6A30	Wearing Surface Type	4A07	Navigational Protection Indicator
6A33	Wearing Surface Thickness	VP02	Bridge Closed, Posted, Open Indicator
VD03	Geometry of Main Beams or Girders	VP03	Special Restrictive Posting
VD05	Types of Steel & Other Metals	VP05	Posted Load Limits (Combination)
6A52	Estimated Cumulative Truck Traffic Count	VP01	Date the Bridge was First & Last Posted
6A54	Eat. Cumulative Truck Traffic – Month & Year	VP01	Date the Bridge was Closed to All Traffic
5B14	Total Number of Spans – Main & Approach	VP06	Reason for Posting or Closing the Bridge
5D05	Spans – Number and Length		
6A44	Fracture Critical Group Number	Not Used	Repair Reference Number
6A48	Critical Rating Factor of FCM Component	Not Used	Date the Bridge was Repaired
6A39	Pavement Relief Joint Indicator	VN07	Drawing Number for the Repair
6A41	Number of Deck Joints on Bridge	Not Used	Type of Repair Work Performed
6A40	Type of Deck Forms Used	Not Used	Cost of Repairs
6A42	Type of Deck Reinforcement Bar Protection	Not Used	Program Under Which Repairs Were Made
VD27	Type of Expansion Joints		
VD30	Type of Bearing	VS04	Sign Structure Type
VD04	Type of Field Splice Used for Steel Bridges	VS11	Number of Signs Displayed on Sign Structure
VD09	Comp. Strength of Beam Concrete at Release	VS28	Number of Spans
VD08	Comp. Strength of Beam Concrete at 28 Days	VS27	Horizontal Length
VD13	Size of Prestressed Strands		
VD11	Prestressed Design Tensioning Method	VW28	Minimum Wall Height
VD07	P/S Strand – Straight or Draped	VW29	Maximum Wall Height
VD06	P/S Beam Vacuum Cure Process Indicator	VW30	Wall Structure Length
VD28	P/S Beam Haunch Type Indicator	VW31	Wall Area
VD12	P/S Beam Void Type	VW04	Wall Type
6A05	Indicator for Presence of Utilities	VW10	Wall Use
VD02	Indicator for Live Load Continuity Design	VW06/VW07	Wall Backfill Material
VD10	Prestressed Beams Field Splice Type	VW26	Backfill Slope
VD14	Abutment Type		
VD15	Abutment Foundation Type		
VD16	Pier Material & Configuration		
VD17	Pier Foundation Type		
VD29	Special Pier Cap Type		
VD23	Tied Arch Culverts Tie Type		

APPENDIX IP 01-F

General Scope of Work – Safety Inspection of State and Local Bridges

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Publication 238 (2021 Edition), Appendix IP 01-F
General Scope of Work – Safety Inspection of State and Local Bridges

Description: Safety Inspection of State and Local Bridges

Objective: Inspect, load rate, inventory and appraise all types of structures and perform follow-up work as directed.

Statement of Work: The requirements of the latest versions of the Department accepted AASHTO and FHWA manuals and the latest versions of Department Publications and Policy, including any updates, shall be followed in the performance of the Scope of Work. See the Department's Bridge Safety Inspection Manual, Publication 238, IP 1.3.2 and IP 1.3.3 for a list.

Scope: The scope of work will include the following activities:

I. TYPES OF SAFETY INSPECTION WORK

A. Initial (First Time) Inspection - Insufficient or no data is available in BMS2. An inspection fulfilling NBIS requirements has never been performed. For bridges carrying highway traffic, a separate Bridge Load Rating work item must also be completed and its results incorporated into this initial inspection report (see Scope Section II.E., "Bridge Load Rating"). Additional inspection requirements for an Initial (First Time) Inspection are outlined in Publication 238, IP 2.3.1.

State-Owned Bridges and Locally-Owned Bridges on the National Highway System (NHS) – An AASHTO / PennDOT bridge element inventory and assessment for bridges has never been performed (this does not include bridges which have previously had a PA CoRe Element inventory/assessment and data is migrated to AASHTO/PennDOT format). Identify and inventory elements and calculate element quantities and scale factors. Identify and record the defect code(s) and condition state quantities for the inventoried elements.

B. Routine Inspection - An NBIS Inspection has been previously completed within the last two (2) years (or 4 years if approved for extended interval) and that inspection report and/or documentation is available. Additional inspection requirements for a Routine Inspection are outlined in Publication 238, IP 2.3.2.

State-owned Bridges and Locally-Owned Bridges on the National Highway System (NHS) - The AASHTO / PennDOT bridge element inventory and assessment for the bridge has been previously completed and documentation is available (this includes bridges which have previously had a PA CoRe Element inventory/assessment and data is migrated to AASHTO/PennDOT format). Identify and inventory elements and calculate element quantities and scale factors. Identify and record the defect code(s) and condition state quantities for the inventoried elements.

C. Other Special (Interim) Inspection - An NBIS Inspection has been previously completed. The structure is included in the BMS2 and the previous inspection report is available. Perform an inspection that is usually limited to portion(s) of the structure which require increased frequency of inspections. Specific inspection requirements are outlined in Publication 238, IP 2.3.5. The scope of work for an Other Special (Interim) Inspection must be approved by the District Bridge Engineer prior to initiating work.

State-owned Bridges - The AASHTO / PennDOT bridge element inventory and assessment for the bridge has been previously completed and documentation is available (this includes bridges which have previously had a PA CoRe Element inventory/assessment and data is migrated to AASHTO/PennDOT format). Identify and inventory elements and calculate element quantities and scale factors. Identify and record the defect code(s) and condition state quantities for the inventoried elements.

D. Supplemental Inspection - Perform in-depth work beyond the scope of Routine inspections, focusing on a specific area or the entire structure (as in an In-Depth Inspections as outlined in Publication 238, IP 2.3.4) or specific components (as in an Other Special (Interim) Inspections as outlined in Publication 238, IP 2.3.5). In-depth tasks may include the following:

- Non-Destructive Testing (except dye penetrant),
- Laboratory Analysis,

- Geotechnical sampling and testing,
- Structure instrumentation, and/or
- Underwater inspection.

The scope of work authorizing a Supplemental Inspection should have provisions for these tasks identified in the LIST OF SPECIAL REQUIREMENTS. The scope of work for an In-Depth or Special type of inspection must be approved by the District Bridge Engineer prior to initiating work.

E. Bridge Load Rating - Perform a structural analysis and load rating of the structure to determine its ability to carry PA's legal loads.

F. Critical Deficiency Meetings - Coordinate and conduct a meeting with local bridge owners to discuss critical structure deficiencies found during the recent inspections.

II. INSPECTION REQUIREMENTS

A. Initial Inventory and Inspection

1. Conduct a complete inventory and field inspection utilizing iForms.
2. Complete BMS2 Inventory data items via BMS2 and Inspection iForms.
3. If structure carries highway traffic, incorporate the Bridge Load Rating performed under separate work item into the initial inspection report. Evaluate bridge for posting needs.
4. Prepare an Inspection Report.

For all State-owned Bridges and Locally-Owned Bridges on the National Highway System (NHS):

5. Identify AASHTO / PennDOT Bridge elements.
6. Calculate element quantities and scale factors.
7. Prepare an element summary table for all elements and provide supporting calculation for each element.
8. Identify and record defect code(s) and condition states for all elements.

B. Routine Inspection

1. All bridges, except closed bridges.
   a. Conduct a complete field inspection utilizing iForms.
   b. Update/supplement the evaluation for posting needs for the structure's current condition. Determine if re-rating is warranted by comparing new vs. existing section loss measurements. If structure is to be re-rated, use the new load rating summary.
   c. Update/amend the Inspection File providing new photographic documentation and/or sketches as needed.
   d. Update and/or complete the required minimum BMS2 inventory and inspection items via BMS2. See Scope Section III.C., "Minimum Required Inventory and Inspection Data," for minimum BMS2 items required.
   e. Incorporate the results of previous or new load ratings into the report.
   f. Prepare an Inspection Report to document all work and findings.

For all State-Owned Bridges and Locally-Owned Bridges on the NHS:

g. Identify and record defect codes and condition states for all elements.

h. Update elements and/or quantities based on changed field conditions.

2. Closed Bridges

a. Inspect bridges closed to highway traffic to assure that the physical barriers are maintained and that the public safety is not jeopardized. Assess the physical integrity of the structure and any potential hazards to the public on or beneath the structure, especially if pedestrian use is to be allowed.

b. Use PennDOT Inspection iForms for field notes. Include a minimum of two (2) photos showing bridge with in-place barriers.

c. Prepare an Inspection Report to document all findings.

3. Partially Closed Bridges

a. Inspect the open portions of bridges partially closed for staged construction as outlined in Scope Section II.B.1.

b. Prepare an Inspection Report to document all findings.

C. Other Special (Interim) Inspection

1. Inspect the specified portion(s) of the structure as authorized by the District Bridge Engineer. Use PennDOT inspection iForms.

2. Update/supplement the posting evaluation of the portion inspected.

3. Update/amend the portion of the Inspection Report dealing with the portion inspected.

4. Update and/or complete the required minimum BMS2 inventory and inspection items via BMS2 relevant to the portion inspected.

5. Prepare an Inspection Report to document all work and findings.

D. Supplemental Inspection

1. Conduct inspection of structure as directed by the Department. Use PennDOT Inspection iForms.

2. Perform follow-up sampling and testing as specified.

3. Update/amend the portion of the Inspection Report dealing with the portion inspected.

4. Update and/or complete the required minimum BMS2 inventory and inspection items via BMS2 dealing with the Supplemental Inspection.

5. Prepare an Inspection Report to document all work and findings.

E. Bridge Load Rating

1. Perform or update the structural analysis and load ratings for all PA legal loads using the latest specification and programs.

2. Identify the structural components or members that govern the ratings.

3. Prepare a load rating summary table and/or stress table for the Inspection Report. Reference calculation page number for ratings.

4. When appropriate update ratings directly in BMS2.

F. Critical Deficiency Meetings

1. Arrange and conduct a meeting with local bridge owners to discuss critical deficiencies found during the inspection.

2. Prepare informal meeting minutes and supply copy of the minutes to the District and municipality.

III. BMS2 INVENTORY AND INSPECTION DATA

A. Department Structures - Complete and/or update all applicable data items of the BMS2 D-491 Forms printout unless otherwise instructed. Complete new forms for new bridges.

B. Local Government Bridges and Others - Provide complete data as in the Scope Section III.A., unless otherwise directed to provide only minimum data.

C. Minimum Required Inventory and Inspection Data - Minimum inventory and inspection data includes all BMS2 Items identified with an asterisk in BMS2 Coding Manual, Publication 100A, and the following BMS2 Items where applicable or attainable:

5C12	Future ADT
5C13	Future ADT Year
5C30	School Bus Route
5C32	Transit Bus Route
6A04	Co Municipality Boundary Code
6A38	Bridge Deck Type
6A43	Approach Pavement Width
6A44	Fracture Critical Group #
6A45-6A48	FCM Critical Ranking Factor
6A53	Cum Truck Traffic for Fatigue Damage
6B24	Agency Hiring Consultant
6B26	Inspection Crew Hours
6B27	Crane Hours
6B32-6B34	Inspection Cost
6B36 6B37	Paint Condition
6B38	Approach Slab Condition
6B39	Approach Roadway Condition
6B40	Deck Wearing Surface Condition
6C10	Highway System
6C11	State Network
6C35-6C38	Vertical Clearance Signing

7A03	Type of Inspection
7A05	Consultant Name, Inspection By
7A09	Inspection Frequency
7A14	Next Inspection By
VP01	Status Date
VP03	Special Restrictive Posting
VP04	Posted Weight Limits
VP06	Reason for Posting or Closing
VD14	Abutment Type
VD15	Abutment Foundation Type
VD16	Pier Type
VD17	Pier Foundation Type
VD19	Length of Culvert
IR06	Rating Method
IR07	IR Controlling Member
IR08	Fatigue Category Controlling Member
IR09	Fatigue Controlling Load Type
IR14	AASHTO Manual Year
IR15	AASHTO Spec Year
IR18	Fatigue Stress Range
IF	Items for FCMs IF01-IF06
IN, IU	All IN and IU items
IM	Items IM01 - IM15 (except IM10)
FR03	Service Status of Railroads
FR04	Railroad Mile Post
FR05	AAR Number
FR06	Number of Electrified Tracks
FW01	Name of Stream
SP01	Span Type
SP02	Label
SP03	Span Length
SP04	Span Deck Width
6B48	Combustible Materials Under the Bridge 1B

Inspection Element Detail Fields

Note: Only applicable items need to be coded. All submitted data will be stored in BMS2. Owners are encouraged to collect and submit all inventory and inspection information available.

IV. FIELD INSPECTION AND ASSESSMENTS

A. Completely inspect all bridge elements including the foundations that support the substructure elements. Clean members as needed to assess condition. For an Other Special (Interim) Inspection, inspect only the specified areas/members. However, report any public safety threatening deficiencies that are observed elsewhere on the bridge. Include inspection of any sign structures attached to the bridge.

B. Clearly record all inspection field notes in iForms. Provide sufficient written comments within iForms to outline the bridge's condition and to justify all condition and appraisal ratings.

Precisely locate and describe deterioration and all areas of section loss. Perform dye penetrant testing if cracking is suspected or found. Determine if current conditions warrant a re-rating for load capacity. Determine if current load posting status is appropriate. Prepare sketches and obtain photographic documentation.

C. Inspect all substructure units and culverts (e.g. abutments, piers, footings, etc.) and culverts visually or by feel (e.g. probing) for condition, scour, integrity, safe load capacity, etc. Use iForms Inspection forms to record findings.

Conduct evaluation of the site and structure to determine the risk from scour. Investigate the scour potential and determine structure stability. Determine channel condition and waterway adequacy. Update scour assessment as warranted. Propose countermeasures appropriate for conditions. Determine the need for an underwater inspection by a professional diver and record reasons in the Recommendation section of the report.

Provide/update plan view sketch of bridge and stream to denote channel changes, scour deposition, etc. Provide/update waterway opening sketch (cross section) to denote bottom of stream, superstructure and substructure units. Measurements from permanent marker should be in table form to compare with previous inspections.

D. Identify locations and provide description of Fracture Critical Members (FCMs) and fatigueprone details. Use iForms, Form F Inspection Form to record findings. Discuss future inspection frequency and procedures for these FCMs. Perform hands-on inspection of all FCM's as indicated in the F&F Plan.

E. Identify and record all maintenance and major improvement needs utilizing iForms Inspection Forms.

F. For State-Owned Bridges and Locally-Owned Bridges on the NHS conduct a complete field AASHTO / PennDOT Bridge element assessment utilizing iForms Inspection Forms. Identify and record condition states for all elements and defect codes. Provide sufficient comments within iForms to describe the element's condition and corresponding location to justify all condition states. Update elements and/or element quantities based on changed field conditions.

G. Provide emergency retrofit schemes, as directed, to any critical conditions uncovered.

H. Arrange for rigging, inspection cranes, platform lift trucks, ladders, boats, etc. The use of safety boats or skiffs should be considered when working over water and the risk of falling is high. Arrange for any needed Traffic Control. Ensure the safety of inspectors and public at all times. Identify these access needs on the Inspection Planning Screen in BMS2.

I. For highway bridges over railroads, coordinate with the railroad to arrange access for inspection of portions of bridges affected by railroad electrification and for railroad protective services while working in the track area and as required by the railroad. Obtain necessary permits and insurance.

V. STRUCTURAL ANALYSIS, LOAD RATING, AND POSTING EVALUATION

A. Acquire authorization from the District Bridge Engineer prior to updating or performing a structural analysis or load rating.

B. Perform or update the structural analysis and load ratings using Load Factor methodology where applicable. Where Load Factor is not applicable, rate the bridge using a method acceptable to AASHTO and the Department. Load rate all bridges at Inventory and Operating levels for AASHTO H, AASHTO HS, PA's ML-80, and PA's TK527 vehicle configurations.

C. Use conventional methods of analysis unless more complex and refined methods are specified or warranted and specifically authorized by the Department. (Refer to Publication 238, IP 3).

D. Identify the structural components or members that govern the ratings. Define any section losses and/or other deficiencies on these members. Provide or reference typical cross-sections and/or framing plans. Include a table of stresses and a rating summary in the report. Reference calculation page number for values in rating summary.

E. Calculate the load ratings using data available from inspection files and reports, supplemental field information and testing data. When no data or drawings (or sketches) are available, field measure members and document findings on a sketch for use in calculating load ratings. The sketch should include enough information to complete the rating analysis including typical cross section with dimensions, remaining section of components (where loss is noted), and locations of deterioration. Sketches shall clearly label elements and members.

F. Ensure that all computations are in accordance with current Department and AASHTO Specifications. Update existing computations accordingly.

When computer analysis is used, provide program input and output, calculations to prepare input, documentation of all assumptions, and any other post-processing calculations. Index computations so key data is readily available.

G. Use the Department's latest version of the appropriate bridge software for analysis and rating, if applicable.

H. Perform a structural analysis of the substructure only if its structural adequacy is at risk due to scour or section loss as a result of the field inspection findings or its unusual component makeup.

I. Evaluate each bridge to determine its capacity in its current condition relative to the four vehicle configurations (H, HS, ML-80, TK527) used to represent PA's legal loads and the need for a weight restriction and the level of posting.

For those situations where the Load Factor method results in lower ratings, a second rating utilizing an accepted method may be used to establish the posting levels.

VI. DRAWINGS

A. Update existing drawings or sketches whenever possible, rather than preparing new drawings.

B. If no plans are available, prepare sufficient drawings to document the makeup of the structure. Include data and view as follows:

1. General plan and elevation.
2. Cross sections.

3. Framing plan.
4. Sketches of structural members (including dimensions).
5. Stress sheets.
6. Results of field inspection, analysis, and historical data, when appropriate.
7. Streambed cross sections, profile and soundings including areas of bed and bank scour.
8. Structural details, including all FCMs unless adequately documented by photographs.

C. For small and/or simple structures, sketches of 8½" X 11" format are acceptable. Prepare sketches using straight edges etc.

D. When retrofit schemes are requested, provide full size plan sheets (22" x 34").

VII. PHOTOGRAPHS

Provide new digital photographs in the inspection report to supplement field inspection notes and drawings and to document current conditions. Provide photographs sufficiently clear, properly identified, dated, and indexed. Photos shall include elevation, approaches, underside, upstream/downstream views, general condition of elements or major components, deficiencies, posting restrictions, structural details and other important features.

VIII. MEETINGS TO DISCUSS CRITICAL DEFICIENCIES WITH LOCAL OWNERS

Discuss all critical structural and safety-related deficiencies, including posting and repair recommendations, as well as critical and high priority proposed maintenance recommendations and alternatives contained in the current inspection report with the bridge owner at a formal meeting. A meeting is not required for critical deficiencies that involve only missing/damaged weight limit, vertical clearance, or any other regulatory signs. For County bridges, a Commissioners' meeting is appropriate. For Municipalities, arrange for appropriate officials to be present. The contracting agency (such as the County, if applicable) may also attend.

Place emphasis of discussion on uncorrected critical and other deficiencies brought forward from the previous inspection report. Ensure these deficiencies are highlighted in the current inspection report. Prepare informal minutes of the meeting that include attendance, issues discussed, proposed solutions, and needed follow-up items for the deficiencies.

This meeting may also be held to discuss inspection findings, general bridge condition and maintenance needs if requested by bridge owner and authorized by the District Bridge Engineer.

A. Convene the meeting within three days after identifying a critical structural deficiency and present a Plan of Action (POA) addressing the deficiencies to the owner. For high priority structure deficiencies, the meeting and POA must be conducted within seven days. Refer to Publication 238, IP 2.13.2. and IP 2.14 for information regarding the general requirements for the POA. During the meeting, ensure the owner has a thorough understanding of the critical nature of the defect(s) and the need for timely action as identified in the POA. Attendance by the engineering services consultant for the local owner is limited to the role of advising, communicating and facilitating the owner's understanding of the deficiency's effects on safety and development of the POA.

B. Provide liaison between the District and the owner when it is necessary to take immediate actions, permanent or temporary in nature, to safeguard public safety (e.g. temporary shoring, bridge closing) before the POA is fully developed.

C. If more time is needed to develop the POA because of the complexity of the problem, request a POA documentation time extension via e-mail to the District Bridge Engineer, copy to the Local Bridge Coordinator and Chief Bridge Engineer, before the end of day 3 for Priority 0's and day 7 for Priority 1's. Include a description of actions taken to date to ensure public safety.

D. The Plan of Action shall provide essential information and be structured to match the BMS2 field information for IM01-IM15. The narrative format must show all maintenance actions and schedule required for repairs and restoration of safety to an acceptable level. In addition to the coding IM01-IM05 describing and prioritizing the deficiency in BMS2, address the following fields:

IM06 Date Recommended

IM07 Status of Work Candidate – Identify if the work will be done by the local owner forces or contractor, and whether work has been completed using appropriate coding. Typical codes include 1,2,5,6. (Note: For local and other owners for codes 1 and 5, "Dept" indicates "owner").

IM08 Target Year IM09 Location

IM11 Work Assign IM12 Drawing Indicator IM13 Permit Indicator IM14b POA Date

IM14a Date Completed and IM14c Mitigated Date must be entered following completion of the work

IM15a Notes - A brief description of steps taken to address the deficiency which can include closing, posting, restricting, traffic temporary shoring, etc. The actions must restore the structure safety to an acceptable level. Note that additional work may be required at a later time to restore full level of service. A schedule for additional work should be included. Following completion of the immediate work and based on justification included in the plan, record the remaining additional repairs in BMS2 and note as such in item IM15b.

E. The meeting with the local owner should not be adjourned until agreement has been reached regarding specific action to be taken and associated schedule. After confirming the finished plan's acceptability with the District Bridge Engineer, enter the appropriate information for each critical deficiency in the BMS2 IM fields (IM01-IM15). Upload documents related to the critical deficiency into BMS2 via the Documents link such as narrative version of the plan, sketches, meeting minutes, etc.

F. Immediately notify the District Bridge Engineer if the critical deficiency will not be addressed within seven (7) days or if the high priority maintenance item will not be addressed within 6 months.

G. Provide follow-up monitoring of the progress toward completion of the POA and report via BMS2 to confirm completion of the approved maintenance action(s) identified in the POA. Follow-up monitoring is also required for regulatory sign critical deficiencies. Enter the completion date(s), IM14a and IM14c, as appropriate in BMS2. The consultant shall immediately notify the owner and the District should problems arise with respect to the completion of the work within the required timeframe.

IX. MATERIAL SAMPLING AND TESTING OR BRIDGE INSTRUMENTATION

Structural materials evaluation, Non-Destructive Testing (except dye penetrant tests) and bridge instrumentation are not a routine part of a bridge inspection. They are to be conducted only when required to eliminate unacceptable engineering uncertainties or to more accurately assess the structure's load carrying capacity.

Justify the use and obtain the District Bridge Engineer authorization before initiating any materials sampling and testing and/or instrumentation program.

X. EXISTING RECORDS AND DATA

The Department will provide BMS2 access for bridges to be inspected.

The Department and owner, if requested, will give the consultant access to any available pertinent information for short term use and copying. This information could include existing bridge drawings, load capacity analysis and design computations, inspection reports and other pertinent information. Files may be made available through the Department's BMS2 application. Some data may be available only on microfilm.

Review the existing records for a bridge prior to the in-field inspection including, but not limited to the following (as applicable): previous inspection report(s) and sketches, past priority maintenance correspondence, as-built or design drawings, current load rating analysis, F&F Plan, existing POAs, etc.

XI. QUALIFICATIONS OF PERSONNEL

Personnel assigned to the Inspection Project by consultant shall meet the qualification requirements set forth in the National Bridge Inspection Standards for all work levels.

For State and Locally-Owned bridges, all inspection personnel must hold a valid certification as "Bridge Safety Inspector" issued by the Department.

XII. TRAFFIC CONTROL

Provide any needed traffic control. Comply with the Department's Publication #213, "Work Zone Traffic Control Guidelines."

XIII. RELEASE OF INFORMATION

Place the stamp appropriate to structure owner per Publication 238, IP 1.8.3 on the front cover of the inspection report. Do not release or distribute inspection information without the written permission of the District Bridge Engineer for State structures or the structure owner.

When portions of a report are approved for release, include the language provide in Publication 238, Figure IP 1.8.3-2 to each page of the structure inspection report that is released.

XIV. AUTHORIZATION OF WORK AND DEADLINES

A. Be prepared to start work immediately upon receiving Notice to Proceed. Complete all work including the final report submission within agreed time schedule. Perform inspections to maintain the 24/48 month inspection frequency or other increased frequency (reduced interval) as specified during the Scope of Work meeting.

B. Upon receipt of Notice to Proceed, start work on all Initial Inventory and Inspection safety inspections, and Periodic (Routine) NBIS Inspections, as they come due.

C. The following work items require the prior authorization by the District Bridge Engineer before work can begin:

- Load Rating (or Re-rating) of Bridges
- Other Special (Interim) Inspections
- Supplemental Inspections
- Critical Deficiency Meetings
- Material Sampling and Testing

- Bridge Instrumentation
- Creation of F&F Plan

Request authorization for work involving these items by submitting appropriate justification to the Department. Outline the proposed scope of work for task on each bridge in the justification. Do not proceed with these tasks until either oral or written authorization from the District Bridge Engineer is received.

Scope Deliverables:

I. INSPECTION REPORT

A. Prepare a report to document the inspection, the bridge, its condition, the structural analysis, load rating, posting evaluation, and recommendations. The report must be 8½" x 11" in size and copied on both sides (when hard copies are requested).

B. A general outline of the report is as follows:

1. Title page (Structure ID Number, BRKEY, bridge name, location, inspection dates, inspector names, prepared for and by, and Pennsylvania P.E. seal, signature and date). Label bridges with Fracture Critical components as "Fracture Critical" on title page, and also label Posted bridges as “Posted”, “New Posting”, or “Posting Change”.
2. Table of contents.
3. Location map(s). Map(s) must be of sufficient detail to locate structure.
4. General description and sketches and/or photographs of the overall structure. Bridge with Fracture Critical members must include a sketch and/or photographs of Fracture Critical member and fatigue prone details.
5. Field inspection findings (completed iForms Inspection Forms, plus photographs and supplemental narrative to document findings).
6. References, list plans, previous reports, etc. used in the preparation of the report.
7. Load rating summary and posting evaluation.
8. Recommendations
9. Appendices:
    a. Inventory Data: Marked-up copy of BMS2 file printout or completed copy of coding D-491 forms.
    b. Inspection Data: Completed iForms Inspection Forms.
    c. Structural analysis and load rating computations and a table of stresses.
    d. Bridge member deficiency sketches where applicable.

C. Include the following in the report Narrative:

1. General description of the structure condition.
2. Summary of inspection findings and comparison with those of previous inspection.
3. Structural adequacy and safety of the structure, the roadway approaches, the bridge railing, the approach guiderail, waterway, and channel. Discuss findings on Fracture Critical items and scour, where applicable.
4. Discuss relevant historical data.

D. Include the following in the Recommendations section:

1. Need for Other Special (Interim) Inspection and/or Supplemental Inspections.
2. Need for new or revised bridge weight restrictions.
3. Signing needs: Vertical clearance, narrow bridge, etc.
4. A prioritized and time scheduled listing of immediate, short and long term improvement needs for:
   a. Maintenance: Complete iForms form M
   b. Rehabilitation: Complete iForms form M or D491IM
   c. Replacement: Complete iForms form M or D491IM

   Recommendations in report should be in "plain English."

E. Other Report Requirements

1. Routine NBIS Inspections without re-rating - The complete detailed structural analysis and load rating computations (see Scope Deliverables, Section I.B.9.c) from previous inspection/rating need not be included, unless otherwise specified. The load rating summary and date of load rating must still be included with the posting evaluation.

   Review/perform the posting evaluation for each bridge to ensure its posting status is appropriate for its just inspected condition.
2. Routine NBIS Inspections for Closed or Partially Closed Bridges - A letter report stating date of inspection, status of closure with photo, iForms Inspection Forms, and other pertinent information will suffice, unless otherwise specified.
3. Other Special (Interim) and Supplemental Inspections - The report format and contents are to be agreed upon at the time of authorization for each structure.

II. EMERGENCY REPORTING

Notify the bridge owner (if applicable) and the District Bridge Engineer immediately whenever a potentially perilous or hazardous condition is observed. Provide written notification to the owner and the District Bridge Engineer within 24 hours. This task is incidental to inspection work. Examples of such situations could include:

- Distress in primary members to the point where there is doubt that the members can safely carry the loads for which they are subjected and partial or complete failure of the bridge is a possibility.
- Scour at or under the abutments or piers of a stream bridge is such that significant movement is likely which could cause the bridge to collapse.
- Substructure movement or distress which is so excessive that there is a clear possibility that it may not be capable of supporting the superstructure and partial or complete failure is a possibility.
- Suspected cracks in pins or hangers of two girder/truss bridges.
- Missing weight restriction signs or vertical clearance signs.
- Any situation where the structural integrity of the bridge is such that its safety is in question.

III. SUBMISSIONS

A. Work Schedule and Status: Submit a horizontal bar graph type work schedule within two weeks of notice to proceed. Submit monthly schedules and progress updates to the District Bridge Engineer and contracting agency.

B. Personnel Qualifications: Thirty (30) days prior to beginning work, submit the list of names and qualifications of inspection personnel to the District Bridge Engineer. For statewide agreements origination from Central Office, submit the list of names to the Section Chief for Bridge Inspection and/or the District Bridge Engineer, as necessary.

C. Field Inspection Data: Submit inspection data from iForms to BMS2 for Department's approval within ten days of the completion of each field inspection. In addition, submit one(1) copy of BMS2 Printout marked with revisions and/or Form D-491 and/or iForms D-450 within ten days of the completion of each field inspection.

D. Draft Inspection Reports: Submit the draft report within 30 days of the completion of each field inspection for review. Space submissions at frequent intervals to facilitate reviews.

E. Final Inspection Reports: For State bridges, submit the Final Report to the District and also upload to the BMS2 Documents link. Submission to the District shall be electronic PDF format unless hard copies are requested by the District. For Local bridges, submit an electronic copy in PDF format to both the District and local owner unless a hard copy report is requested in advance. All hard copy reports are to be bound with non-exposed fasteners.

F. Load Rating/Re-Rating: For State bridges: Submit the Load Rating Analysis (including back-up documentation) within 60 days of each field inspection for review. Submission to the District shall be electronic PDF format unless hard copies are requested by the District. For Local bridges, submit 3 copies and one (1) electronic copy in PDF format to the Districts. Submit BAR7 input file to the District. Update Load Ratings in BMS2.

G. Minutes of Critical Deficiency Meetings with owners: Submit one copy each to District Bridge Engineer, owner, and contracting agency within 7 days of meeting.

H. Plan of Action for Critical Deficiencies: Submit electronically and one paper copy each to District Bridge Engineer and owner with 3 days. For high priority structure deficiencies, the meeting and POA must be conducted within seven days.

I. F&F Plan: For fracture critical bridges with missing or incomplete F&F plans, create and submit a complete F&F plan to be include in the bridge file for use in future inspections (see Publication 238, IP 2.4.5.1).

Sample Exhibit 1 – The following are sample tables, to be created outside of ECMS and attached to the scope of work, as referenced in the Details section of 2.7.5.

EXHIBIT 1 – LIST OF BRIDGES

BRIDGE SAFETY INSPECTION

			Proposed Scope of Work*						
No.	**BMS#**	**Owner**	**Initial NBIS**	**Routine Insp**	**Partial Insp**	**Closed Br Insp**	**Suppl. Insp**	**Load Rating**	**Comments**
1	12-7456-7890-1234	Twp		A1					
2	23-7567-8901-2345	County		A2	I2 (2)				6 month Interim, sub. only, Req'd 2 times.
3	34-7678-9012-3456	County				BC			Closed bridge
4	45-7789-0123-4567	Boro		C2					
5	56-7890-1234-5678	RR	A1						RR over hwy. No load rating req'd
6	67-7901-2345-6789	County		A3				A3	NHS, LF rating needed
7	78-7012-3456-7890	Twp		C1	I4				12 month interim, super only
8	87-7012-3456-7890	Twp	A1						New bridge, design rating available.
9	89-7123-4567-8901	Twp		A2					
10	23-7567-8901-2345	Twp		B1	I5				12 month, floorbeam only
11	34-7678-9012-3456	Twp		A1					
12	45-7789-0123-4567	Twp		A2					
13	56-7890-1234-5678	Twp		B3					
14	67-7901-2345-6789	Twp		A1					
15	78-7012-3456-7890	Twp		A1					
16	87-7012-3456-7890	Twp		A1					
17	89-7123-4567-8901	Twp		A2				S1	See Special Instructions for Suppl Insp SOW
18									
19									
20									

***See Table 1 on next page for Work Categories**

No.	**Critical Deficiency Meetings**	**Category of Work**
1	w/Tionesta Township	**M1**
2	w/Forest County	**M1**

Notes:

1. Unless otherwise noted, only one Interim inspection per bridge allowed.
2. Other Interim inspections will be requested on an as-needed basis.
3. Other Bridge Load Ratings will be requested on as-needed basis.
4. Unless otherwise noted, only one Critical Deficiency Meeting per owner allowed.

Table 1: Work Categories for Proposed Scope of Work		
Structures		Work Category
Types	Length	
Culverts, Slabs, Stringers, Multi-girders, & Arches (Except Open Spandrel Arches)	20'-80'	A1
	81' to 150'	A2
	151' to 300'	A3
	301' to 600'	A4
	601' to 1000'	A5
	Greater than 1000'	A6
	All Lengths (Closed)	AC
Girder/Floorbeam Systems and Open Spandrel Arches	20' to 150'	B1
	151' to 300'	B2
	301' to 600'	B3
	601' to 1000'	B4
	Greater than 1000'	B5
	All Lengths (Closed)	BC
Trusses	20' to 150'	C1
	151' to 300'	C2
	301' to 600'	C3
	601' to 1000'	C4
	Greater than 1000'	C5
	All Lengths (Closed)	CC
All Others	20' to 80'	D1
	81' to 150'	D2
	151' to 300'	D3
	301' to 600'	D4
	601' to 1000'	D5
	Greater than 1000'	D6
	All Lengths (Closed)	DC
Interim		I
Supplemental		S
Critical Deficiency Meetings		M

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APPENDIX IP 01-G

General Scope of Work – Safety Inspection of State and Local Tunnels

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Publication 238 (2021 Edition), Appendix IP 01-G
General Scope of Work – Safety Inspection of State and Local Tunnels

Description: Safety Inspection of State and Local Tunnels

Objective: Inspect, load rate, inventory and appraise tunnels and perform follow-up work as directed.

Statement of Work: The requirements of the latest versions of the Department accepted AASHTO and FHWA manuals and the latest versions of Department Publications and Policy, including any updates, shall be followed in the performance of the Scope of Work. See the Department's Bridge Safety Inspection Manual, Publication 238, IP 1.3.2 and IP 1.3.3 for a list.

Scope: The scope of work will include the following activities:

I. TYPES OF SAFETY INSPECTION WORK

A. Initial (First Time) Inspection - Insufficient or no data is available in BMS2. An inspection fulfilling NTIS requirements has never been performed. For tunnels with structural members carrying highway traffic (directly over or through the tunnel), a separate Tunnel Load Rating work item must also be done and its results incorporated into this initial inspection report (see Scope Section II.E., "Tunnel Load Rating") when applicable. Additional inspection requirements for an Initial (First Time) Inspection are outlined in Publication 238, IP 2.3.1.

B. Routine Inspection - An NTIS Inspection has been previously completed within the last two (2) years and that inspection report and/or documentation is available. Additional inspection requirements for a Routine Inspection are outlined in Publication 238, IP 2.3.2.

C. Other Special (Interim) Inspection - An NTIS Inspection has been previously completed. The structure is included in the BMS2 and the previous inspection report is available. Perform an inspection that is usually limited to portion(s) of the structure which require increased frequency of inspections. Specific inspection requirements are outlined in Publication 238, IP 2.3.5. The scope of work for an Other Special (Interim) Inspection must be approved by the District Bridge Engineer prior to initiating work.

D. Supplemental Inspection - Perform in-depth work beyond the scope of Routine inspections, focusing on a specific area or the entire structure (as in an In-Depth Inspections as outlined in Publication 238 IP 2.3.4) or specific components (as in an Other Special (Interim) Inspections as outlined in Publication 238 IP 2.3.5). In-depth tasks may include the following:

- Non-Destructive Testing (except dye penetrant),
- Laboratory Analysis,
- Geotechnical sampling and testing, and/or
- Structure instrumentation

The scope of work authorizing a Supplemental Inspection should have provisions for these tasks identified in the LIST OF SPECIAL REQUIREMENTS. The scope of work for an In-Depth or Special type of inspection must be approved by the District Bridge Engineer prior to initiating work.

E. Load Rating - Perform a structural analysis and load rating of the structure to determine its ability to carry PA's legal loads when applicable.

F. Critical Finding Meetings - Coordinate and conduct a meeting with local tunnel owners to discuss critical findings noted during the recent inspections.

II. INSPECTION REQUIREMENTS

A. Initial Inventory and Inspection

1. Conduct a complete inventory and field inspection utilizing iForms.

2. Complete BMS2 Inventory data items via BMS2 web and Inspection iForms.

3. If structural members of the tunnel carry highway traffic either directly over or through the tunnel, incorporate the Tunnel Load Rating performed under separate work item into the initial inspection report. Evaluate tunnel for posting needs.

4. Prepare an Inspection Report.

5. Identify SNTI elements.

6. Calculate element quantities.

7. Prepare an element summary table for all elements and provide supporting calculation for each element.

8. Identify and record condition states for all elements, including defects.

B. Routine Inspection

1. All tunnels, except closed tunnels.

   a. Conduct a complete field inspection utilizing iForms.

   b. Update/supplement the evaluation for posting needs for the structure's current condition. Determine if re-rating is warranted by comparing new vs. existing section loss measurements. If structure is to be re-rated, use the new load rating summary.

   c. Update/amend the Inspection File providing new photographic documentation and/or sketches as needed.

   d. Update and/or complete the required minimum BMS2 inventory and inspection items via BMS2 web. See Scope Section III.C., "Minimum Required Inventory and Inspection Data," for minimum BMS2 items required.

   e. Incorporate the results of previous or new load ratings into the report.

   f. Prepare an Inspection Report to document all proposed and completed maintenance recommendations.

   g. Identify and record condition states for all elements.

   h. Update elements and/or quantities based on changed field conditions.

   i. Verify functional systems are being tested on the interval outlined in the tunnel specific inspection documentation and the results of the testing are properly documented in the tunnel file.

2. **Closed Tunnels**

   a. Inspect tunnels closed to highway traffic to assure that the physical barriers are maintained and that the public safety is not jeopardized.

   b. Use PennDOT Inspection iForms for field notes. Include a minimum of two (2) photos showing tunnel with in-place barriers.

   c. Prepare an Inspection Report to document all findings.

3. **Partially Closed Tunnels**

   a. Inspect the open portions of tunnels partially closed for staged construction as outlined in Scope Section II.B.1.

   b. Prepare an Inspection Report to document all findings.

C. Other Special (Interim) Inspection

1. Inspect the specified portion(s) of the structure as authorized by the District Bridge Engineer. Use PennDOT inspection iForms.

2. Update/supplement the posting evaluation of the portion inspected.

3. Update/amend the portion of the Inspection Report dealing with the portion inspected.

4. Update and/or complete the required minimum BMS2 inventory and inspection items via BMS2 web relevant to the portion inspected.

5. Prepare an Inspection Report to document all work and findings.

D. Supplemental Inspection

1. Conduct inspection of structure as directed by the Department. Use PennDOT Inspection iForms.

2. Perform follow-up sampling and testing as specified.

3. Update/amend the portion of the Inspection Report dealing with the portion inspected.

4. Update and/or complete the required minimum BMS2 inventory and inspection items via BMS2 web dealing with the Supplemental Inspection.

5. Prepare an Inspection Report to document all work and findings.

E. Tunnel Load Rating

1. Perform or update the structural analysis and load ratings for all PA legal loads using the latest specification and programs.

2. Identify the structural components or members that govern the ratings.

3. Prepare a load rating summary table and/or stress table for the Inspection Report. Reference calculation page number for ratings.

4. When appropriate update ratings directly in BMS2 web.

F. Critical Finding Meetings

1. Arrange and conduct a meeting with local tunnel owners to discuss critical findings found during the inspection.

2. Prepare informal meeting minutes and supply copy of the minutes to the District and municipality.

III. BMS2 INVENTORY AND INSPECTION DATA

A. **Department Structures** - Complete and/or update all applicable data items of the BMS2 D-491 Forms printout unless otherwise instructed. Complete new forms for new tunnels.

B. **Local Government Tunnels and Others** - Provide complete data as in the Scope Section III.A., unless otherwise directed to provide only minimum data.

C. **Minimum Required Inventory and Inspection Data -** Minimum inventory and inspection data includes the following BMS2 Items:

5A01	Tunnel ID
5A02	Tunnel Name

5A03	Tunnel Number
5A04	Highway Agency District
5A05	County Code
5A06	Place Code
5A08	Facility Carried
5A10	Tunnel Portal's Latitude
5A11	Tunnel Portal's Longitude
5A12	Border Tunnel State or County Code
5A14	State Code
5A15	Year Built
5A16	Year Rehabilitated
5A19	Number of Lanes
5A21	Owner
5B05-5B06	Sidewalk Width
5B18	Tunnel Length
5C04	Route Type
5C06	Route Number, Route Direction
5C08	Total Number of Lanes
5C10	Annual ADT
5C11	Year of Annual ADT
5C12	Future ADT
5C13	Year of Future ADT
5C14	Annual ADTT
5C15	Detour Length
5C18	LRS Mile Point
5C20	LRS Route ID
5C21	Toll
5C22	Functional Classification
5C23	Direction of Traffic
5C27	Roadway Width, Curb-to-Curb
5C28	STRAHNET Designation
5C30	School Bus Route
5C32	Transit Bus Route

6A04	Co Municipality Boundary Code
6A43	Approach Pavement Width
6B24	Agency Hiring Consultant
6B26	Inspection Crew Hours
6B32-6B34	Inspection Cost
6B48	Combustible Materials Stored
6C10	Highway System
6C11	State Highway Network
6C15	NHS Designation
6C20-6C21	Minimum Vertical Clearance
6C35-6C38	Vertical Clearance Signing
7A01	Inspection Date
7A03	Type of Inspection
7A05	Consultant Name
7A08	Last Inspection Date
7A09	Inspection Frequency
7A10	Next Inspection Target Date
7A14	Next Inspection By
VM03-VM04	Inspection/Maintenance Responsibility
VP01	Posting Status Date
VP02	Tunnel Load Posting Status
VP03	Special Restrictive Posting
VP04	Posted Weight Limits
VP06	Reason for Posting or Closing
IR06	Load Rating Method
IR07	IR Controlling Member
IR14	AASHTO Manual Year for Rating
IR15	AASHTO Spec Year for Rating
IM01-IM15	Maintenance Recommendations
1B	Inspection Element Detail Fields
I.17	Border Tunnel Number
A.8	Service in Tunnel
C.8	Urban Code

L.10	Height Restriction
L.11	Hazardous Material Restriction
L.12	Other Restrictions
S.1	Number of Bores
S.2	Tunnel Shape
S.3	Portal Shape
S.4	Ground Condition
S.5	Complex

Note: Only applicable items need to be coded. All submitted data will be stored in BMS2. Owners are encouraged to collect and submit all inventory and inspection information available.

IV. FIELD INSPECTION AND ASSESSMENTS

A. Completely inspect all tunnel elements including civil, mechanical and electrical elements. Verify all functional systems are being tested on the interval specified in the tunnel-specific inspection documentation and the results of the testing are properly documented in the tunnel file. Clean members and disassemble systems as needed to assess condition. For an Other Special (Interim) Inspection, inspect only the specified areas/members. However, report any public safety threatening deficiencies that are observed elsewhere in the tunnel. Include inspection of any sign structures attached to the tunnel.

B. Clearly record all inspection field notes in iForms. Provide sufficient written comments within iForms to outline the tunnel's condition and to justify all condition state classifications. Precisely locate and describe deterioration and all areas of section loss. Perform dye penetrant testing if cracking is suspected or found. Determine if current conditions warrant a re-rating for load capacity. Determine if current load posting status is appropriate. Prepare sketches and obtain photographic documentation.

C. Identify and record all maintenance and major improvement needs utilizing iForms Inspection Forms.

D. Complete field SNTI tunnel element assessment utilizing iForms Inspection Forms. Identify and record condition states for all elements. Provide sufficient comments within iForms to describe the element's condition and corresponding location to justify all condition states. Update elements and/or element quantities based on changed field conditions.

E. Provide emergency retrofit schemes, as directed, to any critical conditions uncovered.

F. Arrange for rigging, inspection cranes, platform lift trucks, ladders, etc. Arrange for any needed Traffic Control. Ensure the safety of inspectors and public at all times.

V. STRUCTURAL ANALYSIS, LOAD RATING, and POSTING EVALUATION

A. Acquire authorization from the District Bridge Engineer prior to performing a structural analysis or load rating.

VI. DRAWINGS

A. Update existing drawings or sketches whenever possible, rather than preparing new drawings.

B. If no plans are available, prepare sufficient drawings to document the makeup of the structure. Include data and view as follows:

1. General plan and elevation.
2. Cross sections.
3. Framing plan.
4. Sketches of structural members (including dimensions).
5. Stress sheets.
6. Results of field inspection, analysis, and historical data, when appropriate.

C. For small and/or simple structures, sketches of 8½" X 11" format are acceptable. Prepare sketches using straight edges etc.

D. When retrofit schemes are requested, provide full size plan sheets (22" x 34").

VII. PHOTOGRAPHS

Provide new digital photographs in the inspection report to supplement field inspection notes and drawings and to document current conditions. Provide photographs sufficiently clear, properly identified, dated, and indexed. Include views of the overall tunnel at each portal, the approach roadway and its alignment, typical condition of major components, deficiencies, posting restrictions, structural details, functional systems and other important features.

VIII. MEETINGS TO DISCUSS CRITICAL FINDINGS WITH LOCAL OWNERS

Discuss all critical structural and safety-related deficiencies (critical findings), including posting and repair recommendations, as well as steps taken to date to ensure public safety in regards to the critical findings with the tunnel owner at a formal meeting. For County tunnels, a Commissioners' meeting is appropriate. For Municipalities, arrange for appropriate officials to be present. The contracting agency (such as the County, if applicable) may also attend.

Place emphasis of discussion on uncorrected critical and other deficiencies brought forward from the previous inspection report. Ensure these deficiencies are highlighted in the current inspection report. Prepare informal minutes of the meeting that include attendance, issues discussed, proposed solutions, and needed follow-up items for the deficiencies.

This meeting may also be held to discuss inspection findings, general tunnel condition and maintenance needs if requested by tunnel owner and authorized by the District Bridge Engineer.

A. Convene the meeting within three days after identifying a critical finding and present a Plan of Action (POA) addressing the deficiencies to the owner. Refer to Publication 238, IP 2.13.2. and IP 2.14 for information regarding the general requirements for the POA. During the meeting, ensure the owner has a thorough understanding of the critical nature of the defect(s) and the need for timely action as identified in the POA. Attendance by the engineering services consultant for the local owner is limited to the role of advising, communicating and facilitating the owner's understanding of the deficiency's effects on safety and development of the POA.

B. Provide liaison between the District and the owner when it is necessary to take immediate actions, permanent or temporary in nature, to safeguard public safety (e.g. temporary shoring, tunnel closing) before the POA is fully developed.

C. If more time is needed to develop the POA because of the complexity of the problem, request a POA documentation time extension via e-mail to the District Bridge Engineer, copy to the Local Bridge Coordinator and Bridge Inspection Section Chief, before the end of day 3. Include a description of actions taken to date to ensure public safety.

D. The Plan of Action shall provide essential information and be structured to match the BMS2 field information for IM01-IM15. The narrative format must show all maintenance actions and schedule required for repairs and restoration of safety to an acceptable level. In addition to the coding IM01-IM05 describing and prioritizing the deficiency in BMS2, address the following fields:

IM06 Date Recommended

IM07 Status of Work Candidate – Identify if the work will be done by the local owner forces or contractor, and whether work has been completed using appropriate coding. Typical codes include 1,2,5,6. (Note: For local and other owners for codes 1 and 5, "Dept" indicates "owner").

IM08 Target Year IM09 Location

IM10 Estimated Cost IM11 Work Assign IM12 Drawing Indicator IM13 Permit Indicator IM14b POA Date

IM14a Date Completed and IM14c Mitigated Date must be entered following completion of the work

IM15a Notes - A brief description of steps taken to address the deficiency which can include closing, posting, restricting, traffic temporary shoring, etc. The actions must restore the structure safety to an acceptable level. Note that additional work may be required at a later time to restore full level of service. A schedule for additional work should be included. Following completion of the immediate work and based on justification included in the plan, record the remaining additional repairs in BMS2 and note as such in item IM15b.

E. The meeting with the local owner should not be adjourned until agreement has been reached regarding specific action to be taken and associated schedule. After confirming the finished plan's acceptability with the District Bridge Engineer, enter the appropriate information for each critical finding in the BMS2 IM fields (IM01-IM15). Upload documents related to the critical deficiency to the BMS2 Documents link such as narrative version of the plan, sketches, meeting minutes, etc.

F. Immediately notify the District Bridge Engineer if the critical finding will not be addressed within a timely manner. Timeframe for repairs shall be set by the District Bridge Engineer at the meeting.

G. Provide follow-up monitoring of the progress toward completion of the POA and report via BMS2 to confirm completion of the approved maintenance action(s) identified in the POA. Follow-up monitoring is also required for regulatory sign critical deficiencies. Enter the completion date(s), IM14a and IM14c, as appropriate in BMS2. The consultant shall immediately notify the owner and the District should problems arise with respect to the completion of the work within the required timeframe.

IX. MATERIAL SAMPLING AND TESTING OR TUNNEL INSTRUMENTATION

Structural materials evaluation, Non-Destructive Testing (except dye penetrant tests) and instrumentation are not a routine part of a tunnel inspection. They are to be conducted only when required to eliminate unacceptable engineering uncertainties or to more accurately assess the structure's load carrying capacity.

Justify the use and obtain the District Bridge Engineer or local Owner authorization before initiating any materials sampling and testing and/or instrumentation program.

X. EXISTING RECORDS AND DATA

The Department will provide BMS2 web access for tunnels to be inspected.

The Department and owner, if requested, will give the consultant access to any available pertinent information for short term use and copying. This information could include existing tunnel drawings, load capacity analysis and design computations, inspection reports and other pertinent information. Files may be made available through the Department's BMS2 web application.

Review the existing records for a tunnel prior to the in-field inspection including, but not limited to the following (as applicable): tunnel-specific inspection procedures document, previous inspection report(s) and sketches, past priority maintenance correspondence, as-built or design drawings, current load rating analysis, existing POAs, etc.

XI. QUALIFICATIONS OF PERSONNEL

Personnel assigned to the Inspection Project by consultant shall meet the qualification requirements set forth in the NTIS for all work levels.

All inspection personnel must be registered with the Bridge Inspection Section Chief as detailed in Section IP 2.1.3.3.

XII. TRAFFIC CONTROL

Provide any needed traffic control. Comply with the Department's Publication 213, Work Zone Traffic Control Guidelines.

XIII. RELEASE OF INFORMATION

Place the stamp appropriate to structure owner per Publication 238, IP 1.8.3 on the front cover of the inspection report. Do not release or distribute inspection information without the written permission of the District Bridge Engineer for State structures or the structure owner.

When portions of a report are approved for release, include the language provided in Figure IP 1.8.3-2 to each page of the structure inspection report that is released.

XIV. AUTHORIZATION OF WORK AND DEADLINES

A. Be prepared to start work immediately upon receiving Notice to Proceed. Complete all work including the final report submission within agreed time schedule. Perform inspections to maintain the 24-month inspection frequency or other increased frequency (reduced interval) as specified during the Scope of Work meeting.

B. Upon receipt of Notice to Proceed, start work on all Routine NTIS Inspections, as they come due.

C. The following work items require the prior authorization by the District Bridge Engineerbefore work can begin:

- Load Rating (or Re-rating) of Tunnels
- Other Special (Interim) Inspections
- Supplemental Inspections
- Critical Finding Meetings
- Material Sampling and Testing
- Structure Instrumentation
- Creation of Tunnel Specific Inspection Procedures Document

Request authorization for work involving these items by submitting appropriate justification to the Department. Outline the proposed scope of work for task on each tunnel in the justification. Do not proceed with these tasks until either oral or written authorization from the District Bridge Engineer is received.

Scope Deliverables:

I. INSPECTION REPORT

A. **Prepare a report** to document the inspection, the tunnel, its condition, the structural analysis, load rating, posting evaluation, results of functional system checks, critical findings, and recommendations. The report must be 8½" x 11" in size and copied on both sides (when hard copies are requested).

B. A general outline of the report is as follows:

1. Title page (Structure ID Number, BRKEY, tunnel name, location, inspection dates, inspector names, prepared for and by, and Pennsylvania P.E. seal, signature and date). Label Posted tunnels as "Posted", "New Posting", or "Posting Change".
2. Table of contents.
3. Location map(s). Map(s) must be of sufficient detail to locate structure.
4. General description and sketches and/or photographs of the overall structure.
5. Field inspection findings (completed iForms Inspection Forms, plus photographs and supplemental narrative to document findings).
6. References, list plans, previous reports, etc. used in the preparation of the report.
7. Load rating summary and posting evaluation.
8. Recommendations
9. Appendices:
    a. Inventory Data: Marked-up copy of BMS2 file printout or completed copy of coding D-491 forms
    b. Inspection Data: Completed iForms Inspection Forms.
    c. Structural analysis and load rating computations and a table of stresses.
    d. Member deficiency sketches where applicable.

C. Include the following in the report Narrative:

1. General description of the structure condition.
2. Summary of inspection findings and comparison with those of previous inspection.
3. Structural adequacy and safety of the structure and all systems and components.
4. Discuss relevant historical data.

D. Include the following in the Recommendations section:

1. Need for Other Special (Interim) Inspection and/or Supplemental Inspections.
2. Need for new or revised weight restrictions.
3. Signing needs: Vertical clearance, etc.
4. A prioritized and time scheduled listing of immediate, short- and long-term improvement needs for:
    a. Maintenance: Complete iForms form M
    b. Rehabilitation: Complete iForms form M or D491IM

c. Replacement: Complete iForms form M or D491IM

Recommendations in report should be in "plain English."

E. Other Report Requirements

1. Routine NTIS Inspections without re-rating - The complete detailed structural analysis and load rating computations (see Scope Deliverables, Section I.B.9.c) from previous inspection/rating need not be included, unless otherwise specified. The load rating summary and date of load rating must still be included with the posting evaluation.

Review/perform the posting evaluation for each tunnel to ensure its posting status is appropriate for its just inspected condition.

2. Routine NTIS Inspections for Closed or Partially Closed Tunnels - A letter report stating date of inspection, status of closure with photo, iForms Inspection Forms, and other pertinent information will suffice, unless otherwise specified.

3. Other Special (Interim) and Supplemental Inspections - The report format and contents are to be agreed upon at the time of authorization for each structure.

II. EMERGENCY REPORTING

Notify the tunnel owner and the District Bridge Engineer immediately whenever a potentially perilous or hazardous condition is observed. Provide written notification to the owner, the District Bridge Engineer and FHWA within 24 hours. This task is incidental to inspection work. Examples of such situations could include:

- Distress in primary members to the point where there is doubt that the members can safely carry the loads for which they are subjected and partial or complete failure of the tunnel is a possibility.
- Substructure movement or distress which is so excessive that there is a clear possibility that it may not be capable of supporting the superstructure and partial or complete failure is a possibility.
- Missing weight restriction signs or vertical clearance signs.
- Any situation where the structural integrity of the tunnel is such that its safety is in question.

III. SUBMISSIONS

A. Work Schedule and Status: Submit a horizontal bar graph type work schedule within two weeks of notice to proceed. Submit monthly schedules and progress updates to the District Bridge Engineer and contracting agency.

B. Personnel Qualifications: Thirty (30) days prior to beginning work, submit the list of names and qualifications of inspection personnel to the Bridge Inspection Section Chief.

C. Field Inspection Data: Submit inspection data from iForms to BMS2 web for Department's approval within 30 days of the completion of each field inspection. In addition, submit BMS2 Printout marked with revisions and/or Form D-491 and/or iForms D-450 within 30 days of the completion of each field inspection.

D. Draft Inspection Reports: Submit the draft report within 60 days of the completion of each field inspection for review. Space submissions at frequent intervals to facilitate reviews.

E. Final Inspection Reports: For State tunnels, submit the Final Report to the District after acceptance of the draft.

F. Critical Findings: Submit documentation of critical findings to FHWA and the Program Manager within 24 hours of discovery. Contact information and responsibilities are outlined in the tunnel specific inspection agreement.

G. Plan of Action for Critical Findings: Submit to District Bridge Engineer, owner and FHWA within 3 days.

H. Minutes of Critical Finding Meetings with Owners: Submit to District Bridge Engineer, owner, FHWA, and contracting agency within 7 days of meeting.

Tunnel-Specific Inspection Procedures Document: For tunnels with an incomplete or missing tunnel-specific inspection procedures, complete and submit this document to be include in the tunnel file for use in future inspections.

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APPENDIX IP 01-H

General Scope of Work –
Underwater Inspection of Bridges

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Publication 238 (2021 Edition), Appendix IP 01-H
General Scope of Work – Underwater Inspection of Bridges

Description: Underwater Bridge Inspection – Cost per Unit

Objective: Underwater bridge inspection

Statement of Work:

I. GENERAL

A. Purpose: Inspect and appraise the underwater portion of bridges.

B. Guidance: The requirements of latest versions of the Department accepted AASHTO and FHWA manuals and the latest versions of Department Publications and Policy, including any updates, shall be followed in the performance of the Scope of Work. See the Department's Bridge Safety Inspection Manual, Publication 238, IP 1.3.2 and IP 1.3.3 for a list.

C. Scope: This scope will include the following activities:

II. TYPES OF UNDERWATER INSPECTION WORK

A. Description of Work Types

Diving Underwater bridge inspections that require hard hat/scuba diving.

Probing Underwater bridge inspection performed by probing and/or sounding methods.

Mobilization Pre-inspection work required for diving inspections

Travel Travel to and from the bridge and/or for specific work types

Meetings Participation in meetings with bridge owners. For locally-owned bridges, this may include additional units to develop a POA.

Special Underwater bridge inspection related work not covered by the other types of work and as directed by the Bureau of Maintenance and Operations. This work may include field work, reports, studies, and other tasks.

B. Categories of Work

Work for diving and probing inspections is to be divided into categories related to the water depth, water velocity, and number of units to be inspected at each bridge site as indicated in Exhibit 1.

C. Assignment of Work

1. Diving and Probing Inspections

The Districts will assign this work to the Consultant via Work Orders listing the bridges and substructures to be inspected.

Prior to finalizing your work schedule for a Work Order, review and verify the available information on the list of assigned bridges with the District (and local owner if appropriate) to confirm that the Type and Category of Work proposed is consistent for the work required at each site. This review will minimize duplication of effort and will provide the basis for formulating specific directions and expectations on each structure.

2. Mobilization

The District may authorize and assign this work to the consultant for diving inspections based on the depth of the water and the specialized equipment required for certain inspections.

3. Travel

The District may authorize and assign this work to the consultant for either diving inspections based on the depth of water or to meet with bridge owners.

4. Meeting with Bridge Owners

The District may authorize and assign this work to the consultant if requested by the bridge owner. If a critical deficiency is identified, the District may authorize specific POA units for the consultant to develop the POA for the local owner.

5. Special Underwater Inspection Related Work

This work may only be authorized and assigned by the Bridge Inspection Section Chief of the Asset Management Division.

D. Cold Weather Adjustment for Inspections

1. Cold Weather (Diving)

A Cold Weather Add-On Cost is to be allowed for diving inspections when the site's ambient temperature at the time of inspection is less than 35 degrees Fahrenheit.

2. Cold Weather (Probing)

For cold weather probing inspections, a Cold Weather Add-On Cost may be allowed for emergency inspections where ambient temperature is less than 20 degrees Fahrenheit or if the ice surrounding at the substructure unit is at least 4" thick or more at the time of inspection.

3. Water Velocity (Diving)

For diving inspections, a Water Velocity Add-On Cost is to be allowed for diving inspections when the sites water velocity exceeds 3 feet per second.

All approvals will require documentation in the inspection report of the site conditions for which the consultant is requesting additional units. For State and Local bridges, authorization will be made at the District level. For Other State Agency bridges, authorizations will be granted by the Bridge Inspection Section within the Bureau of Maintenance and Operations.

III. BMS2 DATA

Complete all applicable portions of the bridge inspection forms, BMS2 Coding FormsD-450's and/or the BMS2 file printout, including items 5A07, VD14-VD17, 6A51, FW11, 4A21-4A24, 6A10, VI12, 6B01, 7A03, 7A05, 7A06, 7A07, 7A09, 7A10, 6B26, 1A02, 1A05, 1A03, 1A06, 6B48, 4A08, the IN, IU and IM screens as it relates to channel, waterway, substructure, plan of actions, etc. as well as inspection element-level fields.

IV. FIELD INSPECTION

A. General

1. Prior to beginning field inspection, inform the bridge owner of the schedule andthe names of the inspectors.
2. Record the ambient temperature, water velocity, and ice thickness at each substructure at the time of inspection.

B. Structure Inspection

1. Inspect the portions subjected to being submerged for damage, cracking, settlement, steel corrosion, deteriorated and scoured concrete, deteriorated pointing, broken and/or dislodged stones in masonry structures, deterioration and/or damage to piling, insect damage or wood decay, etc.

2. Provide special attention to determine the uniformity of bearing of footings and surrounding foundation materials and the lateral stability and soil support to the pile foundations, the effect or potential effect of scour, and also the soundness or effectiveness of any previous repairs.

3. Sound all timber and probe with a heavy duty 6-inch (min.) blade, ice pick or awl.

4. Identify limits of past scour protection.

C. Streambed Inspection

1. Inspect the streambed in the area of the substructure unit as to type of material, evidence of scour, condition of existing scour protection, debris, etc. Obtain elevations relative to a fixed permanent reference point marker to provide for accurate plotting of streambed contours and/or streambed profiles in the areas suspect of scour.

2. Provide stream bottom data on a minimum five (5) foot grid around each pier to extend beyond the scour hole but in no case less than twenty-five (25) feet beyond the footing area. Estimate flow velocities and direction of flow relative to the foundation structure. Note all turbulence and unusual flow conditions.

3. Obtain channel cross-sections at the bridge and two bridge lengths upstream and downstream. For bridge lengths, greater than 100', obtain channel cross-sections at 200' upstream and downstream. Significant features directly observable but beyond 200' from the bridge should be included. Do not create new cross-sections, if existing cross- sections can be utilized. Mark any changes on the existing cross-sections from the bridge inspection file.

   The cross section at the fascia must include the following:

   a. Top-of-bank to top-of-bank channel section at upstream face of bridge.

   b. Geometry of principal bridge openings up to the anticipated high-water elevation.

   c. Foundation units.

   d. Stream bed materials and boring information.

   e. Roadway profile in the vicinity of the bridge.

   f. Discernible scour holes.

   g. Structural countermeasures at the bridge.

   h. Discernible high-water marks at the bridge.

   i. Stream level at the upstream side of the bridge at time of inspection.

   j. Reference marks on the bridge.

   k. The upstream and downstream sections may be sounded from a surveyed water surface elevation. Obtain sounding by using a continuous reading strip chart Fathometer unless water conditions preclude use of a boat, in which case sounding poles or lead lines may be utilized.

D. Reference Point Marker

Place a permanent marker if one does not exist already (drill hole, nonferrous PK nail) on each abutment/pier (elevation/datum) that correlates to the report findings and which may be used in future underwater investigations and/or rehabilitation work. Provide one such marker per unit at a convenient location. This bench mark is to be referenced on the plan.

E. Verification of Field Conditions for the Observed Scour Assessment

At the substructure units being inspected, verify and update the field conditions recorded in the most recent

Observed Scour Assessment Report. The District will provide one copy of the appropriate portions of the Observed Scour Assessment Report.

In the “UNDER THE BRIDGE” section of the Assessment, review data applicable to the substructure units being inspected. Mark all changes in red ink without erasing or obliterating original information. If previous information is valid, note each data item as such with a checkmark or the words “No change”. Update the Plan Sketch and Channel Cross Section at the Bridge accordingly. Record the date of the underwater inspection and inspection leader on each page.

This update of the Scour Assessment Plan and Cross Section is not in lieu of and does not satisfy the Underwater Inspection Report requirements set forth in Sections IV, Parts A through D and V of this Scope.

F. State-owned Bridges and Locally-Owned Bridges on the National Highway System (NHS) -

The AASHTO / PennDOT bridge element inventory and assessment for the bridge has been previously completed and documentation is available (this includes bridges which have previously had a PA CoRe Element inventory/assessment and data is migrated to AASHTO/PennDOT format). Identify and inventory elements and calculate element quantities and scale factors. Identify and record the defect code(s) and condition state quantities for the inventoried elements.

V. DRAWINGS

A. General

Prepare sufficient drawings to document the condition of the substructure units and stream. Use sketch abbreviations, terminology, and symbols as shown on the attached sketches and list of abbreviations (Attachment A).

B. Type 1 Diving Inspection Requirements

Include the following:

1. General plan, elevation, and contours.
2. Channel Cross sections showing Foundation Material, Footings, portions of substructure units which are underwater, remediation material and areas of scour.
3. Results of underwater inspections including details of section loss due to deterioration, or damage.
4. Streambed profile and soundings including areas of bed and bank scour.
5. Unusual structural elements unless documented by photographs.

C. Probing Inspection Requirements

For probing inspection furnish all the diving inspection information available.

D. Special Inspection Requirements

Drawing requirements for special inspections must be detailed in the proposal if available.

VI. PHOTOGRAPHS

Provide new photographs of the bridge and new underwater photographs to supplement field inspection notes and drawings. Photos may be used in lieu of detail sketches if the pictures are sufficiently clear, adequately dimensioned, and are properly identified and indexed.

Xerographic/laser copies of photographs, electronically scanned prints, and prints from a digital electronic camera are acceptable substitutes for report photographs if the resolution and quality is acceptable to the Districts.

VII. INSPECTION REPORT

A. Report Requirements

Provide a written report using explicit terminology and language covering the factors relevant to the condition of the substructure, such as:

1. Detail general condition as revealed by the field inspection; past, present and potential flooding conditions, if relevant; history of repairs; and all other features which may affect the service life of the substructure.
2. Provide detailed descriptions of the inspection. Such details shall be referenced and shown on the drawings. Sketches should be such that aggradation and degradation of material around piers can be readily identified during subsequent inspections.
3. Compare channel cross-sections with those obtained in previous inspections and significant stream changes shall be identified.
4. Provide recommendations as to: need for minor repairs; need for major repairs; scheduling of repairs; anticipated useful life of the substructure; recommended intervals for future inspections; and any other recommendations which may be pertinent to the perpetual safety of the structure, such as scour computations or substructure analysis.
5. When repairs are recommended, estimate quantities and cost of the repairs. Prioritize these repairs.
6. Highlight critical deficiencies and/or other important findings on a separate sheet(s).
7. List names of Certified Divers in the report.
8. Sign and seal the report by a Professional Engineer licensed in Pennsylvania.

B. Submission of Reports

1. Draft Report:

Submit a draft copy of the inspection report to the Engineering District within four weeks of completion of each field inspection for review and comments. For the first five draft reports completed, also submit a copy to the Bureau of Maintenance and Operations.

2. Final Report:

Submit the final report within four weeks after receipt of review/comments of the draft copy. An electronic submission is preferred. Only submit a hard copy if requested by the District.

3. Submission Schedule:

Space submissions at frequent intervals to facilitate review.

VIII. QUALIFICATIONS OF PERSONNEL

Personnel assigned to the Inspection Project by consultant shall meet the requirements set forth in the National Bridge Inspection Standards for all work levels.

A Professional Engineer shall be on-site at all times during the inspection, either in the boat or as an underwater bridge inspection diver.

A Team Leader meeting NBIS qualifications requirements shall be on site at all times during the inspection. The Team Leader must also hold a valid certification as “Bridge Safety Inspector” issued by the Department. The Professional Engineer on site or the underwater bridge inspection diver can also be the Team Leader if they meet all the requirements of this paragraph.

Prior to the start of this work, submit a detailed resume of each inspection team member for approval to the Bureau of Maintenance and Operations. Team members may be added later provided similar approval has been granted.

A. Engineer in charge – the engineer in charge of an inspection and preparation of the inspection report must possess the following minimum qualifications:

a. Be a Professional Engineer licensed in Pennsylvania.

b. Have a minimum of five years' experience in underwater inspection assignments in responsible capacity

c. Must hold a valid certification as a Bridge Safety Inspector issue by the Department.

B. Underwater Bridge Inspection Diver – The underwater diver shall:

a. Hold a valid certification as Bridge Safety Inspector issued by the Department OR

b. Successfully completed NHI's Course No. 130091 – Underwater Bridge Inspection within the last two years*.

*Note: An individual using NHI's 130091 Course to qualify as a diver, may only serve as the underwater diver for an inspection in Pennsylvania. The Team Leader and On-Site Professional Engineer for the Underwater Inspection must hold a valid certification as a Bridge Safety Inspector issued by the Department.

IX. SAFETY OF PERSONNEL

Safety is of utmost importance. Take all necessary precautions for the safeguard of all personnel involved in this project and follow all applicable Department and OSHA, Part 1910 requirements.

X. REPORTING CRITICAL DEFICIENCIES TO OWNER

Contact owner and District Bridge Engineer immediately if there is an emergency situation (i.e. critical deficiency). Telephone conversation and notes/sketches sent by email or facsimile will suffice for initial notification.

Place emphasis on discussion of uncorrected critical and other high priority deficiencies brought forward from the previous inspection report. Highlight these deficiencies in the current inspection report.

This task is to be considered incidental to diving and probing inspection work.

XI. MEETINGS WITH BRIDGE OWNERS

This work is to provide for meetings to interpret and discuss the technical findings of the underwater bridge inspection reports with the bridge owners and/or public.

Discuss critical structural and safety related deficiencies, recommendations and alternatives contained in the report. Make summary notes of the meeting, including any handouts provided, attendance list, items discussed, and any follow-up items needing resolution. Provide three copies of the notes (one copy to owner, District Bridge Engineer and Bureau of Maintenance and Operations), within one week of the meeting.

XII. MEETING TO DISCUSS CRITICAL DEFICIENCIES WITH LOCAL OWNERS

Discuss all critical structural and safety-related deficiencies, including posting and repair recommendations, as well as critical and high priority proposed maintenance recommendations and alternatives contained in the current inspection report with the bridge owner at a formal meeting. A meeting is not required for critical deficiencies that involve only missing/damaged weight limit, vertical clearance, or any other regulatory signs. For County bridges, a Commissioners' meeting is appropriate. For Municipalities, arrange for appropriate officials to be present. The contracting agency (such as the County, if applicable) may also attend.

Place emphasis of discussion on uncorrected critical and other deficiencies brought forward from the previous inspection report. Ensure these deficiencies are highlighted in the current inspection report. Prepare informal minutes of the meeting that include attendance, issues discussed, proposed solutions, and needed follow-up items for the deficiencies.

This meeting may also be held to discuss inspection findings, general bridge condition and maintenance needs if requested by bridge owner and authorized by the District Bridge Engineer.

A. Convene the meeting within three days after identifying a critical structural deficiency and present a Plan of Action (POA) addressing the deficiency to the owner. For high priority structure deficiencies, the meeting and POA must be conducted within seven days. Refer to Publication 238, IP 2.13.2. and IP 2.14 for information regarding the general requirements for the POA. During the meeting, ensure the owner has a thorough understanding of the critical nature of the defect(s) and the need for timely action as identified in the POA. Attendance by the engineering services consultant for the Local Owner is limited to the role of advising, communicating and facilitating the owner's understanding of the deficiency's effects on safety and development of the POA.

B. Provide liaison between the District and the owner when it is necessary to take immediate actions, permanent or temporary in nature, to safeguard public safety (e.g. temporary shoring, bridge closing) before the POA is fully developed.

C. If more time is needed to develop the POA because of the complexity of the problem, request a POA documentation time extension via e-mail to the District Bridge Engineer, copy to the Local Bridge Coordinator and Chief Bridge Engineer, before the end of day 3 for Priority 0's and day 7 for Priority 1's. Include a description of actions taken to date to ensure public safety.

D. The Plan of Action shall provide essential information and be structured to match the BMS2 field information for IM01-IM15. The narrative format must show all maintenance actions and schedule required for repairs and restoration of safety to an acceptable level. In addition to the coding IM01-IM05 describing and prioritizing the deficiency in BMS2, address the following fields:

IM06 Date Recommended

IM07 Status of Work Candidate – Identify if the work will be done by the local owner forces or contractor, and whether work has been completed using appropriate coding. Typical codes include 1,2,5,6. (Note: For local and other owners for codes 1 and 5, "Dept" indicates "owner").

IM08 Target Year IM09 Location

IM10 Estimated Cost IM11 Work Assign IM12 Drawing Indicator IM13 Permit Indicator IM14b POA Date

IM14a Date Completed and IM14c Mitigated Date must be entered following completion of the work

IM15a Notes - A brief description of steps taken to address the deficiency which can include closing, posting, restricting, traffic temporary shoring, etc. The actions must restore the structure safety to an acceptable level. Note that additional work may be required at a later time to restore full level of service. A schedule for additional work should be included. Following completion of the immediate work and based on justification included in the plan, record the remaining additional repairs in BMS2 and note as such in item 15b.

E. The meeting with the Local Owner should not be adjourned until agreement has been reached regarding specific action to be taken and associated schedule. After confirming the finished plan's acceptability with the District Bridge Engineer, enter the appropriate information for each critical deficiency in the BMS2 IM fields (IM01-IM15). Upload documents related to the critical deficiency to the BMS2 Documents link such as narrative version of the plan, sketches, meeting minutes, etc.

F. Immediately notify the District Bridge Engineer if the critical deficiency will not be addressed within seven (7) days or if the high priority maintenance item will not be addressed within 6 months.

G. Provide follow-up monitoring of the progress toward completion of the POA and report via BMS2 to confirm completion of the approved maintenance action(s) identified in the POA. Follow-up monitoring is also required for regulatory sign critical deficiencies. Enter the completion date(s), IM14a and IM14c, as appropriate in BMS2. The consultant shall immediately notify the owner and the District should problems arise with respect to the completion of the work within the required timeframe.

XII. SPECIAL UNDERWATER INSPECTION RELATED WORK

The description and requirements of this work will be determined at the time of assignment.

XIII. NONPROFESSIONAL SERVICES BY OTHERS

Examples of this type of work include, but are not limited to:

a. Use of Geophysical methods to detect scour

b. Nondestructive testing of subsurface elements

c. Coring of wood or concrete

d. Soil sampling of material around units and upstream

These items, when sub-contracted, will be paid as a direct cost for non-professional services. The consultant will be paid the actual cost based on certified invoices.

If the anticipated cost for non-professional services exceeds Ten Thousand and 00/100 Dollars ($10,000.00) per Work Order, solicit three (3) bids for that work. The responsible vendor submitting the lowest bid shall be engaged for the services.

XIV. METHOD OF PAYMENT

The method of payment for this will be Cost Per Unit of Work, based on the Categories of Work listed in Exhibit 1.

The Cold Weather Add-On Cost will be paid only for those substructures authorized by the Department.

XV. DEADLINES

Prepare to start work immediately upon receiving Notice to Proceed. Complete all work expeditiously, but not later than the date specified in each Work Order.

XVI. DEPARTMENT PROJECT MANAGEMENT

PennDOT Project Manager:

Bridge Inspection Section in Asset Management Division of the Bureau of Maintenance and Operations Work Order Administrator and Technical Review:

District Bridge Unit in the Engineering District issuing Work Order.

XVII. RELEASE OF INSPECTION INFORMATION

Place the stamp appropriate to structure owner per Publication 238, IP 1.8.3 on the front cover of the inspection report. Do not release or distribute inspection information without the written permission of the District Bridge Engineer for State structures or the structure owner.

When portions of a report are approved for release, include the language provided in Publication 238, Figure IP 1.8.3-2 to each page of the structure inspection report that is released.

***Sample Exhibit 1* –** The following are sample tables, to be created outside of ECMS and attached to the scope of work, as referenced in the Details section of 2.7.5.

EXHIBIT 1 – LIST OF BRIDGES UNDERWATER INSPECTION

		Proposed Scope of Work								
BRKEY	**BMS#**	**MOB Dive < 30'**	**MOB Probing**	**Dive < 15'**	**Probe Unit**	**Report, Initial Dive Unit**	**Report, Additional Units**	**Report, Probe Unit**	**Travel Time Dive Team**	**Units/Comments**
30940	53-7230-0435-0301	1		1		1			3	FAB
30986	53-7405-0000-0421	1		1	2	1	2		3	NAB, P01, FAB
43171	48-7215-0000-0001	1		1		1			3	FAB
23530	39-7404-0000-9001	1		1		1			3	P04
30878	53-7207-0753-0073	1		1		1			3	NAB
23492	39-7301-0000-0015	1		1		1			3	P01
23484	39-7212-0810-9027	1		1	1	1	1		3	NAB/FAB
23503	39-7301-0000-9001	1		1	2	1	2		3	NAB, P01, Intrados
23511	39-7301-0000-9029	1		1		1			3	P02
43171	48-7215-0000-0001	1		1		1			3	FAB, 6 mth interim
5487	06-7301-0000-9171	1		1		1			3	P04
5366	06-7215-0505-9466	1		1	2	1	2		3	P01, P02, P03
	Unforeseen	1	1	1	1	1		1	4	

No.	Critical Deficiency Meetings	Category of Work
1	w/ Union Township	**M1**
2	w/ Lehigh County	**M1**

Note: Unless otherwise noted, only one Critical Deficiency Meeting per owner allowed.

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APPENDIX IP 01-I

Minimum Inventory/Inspection Items for Non-Highway Bridges over State Routes

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Publication 238 (2021 Edition), Appendix IP 01-I
Minimum Inventory/Inspection Items for Non-Highway Bridges over State Routes

Follow the General Scope of Work – Safety Inspection of State and Local Bridges for the inspection of non-highway structures over state routes. Since the inspection of non-highway structures is not reported to the NBIS, the Department requires less inventory and inspection data be collected for these structures.

Minimum Required Inventory Data:

Minimum inventory data includes all BMS2 Items identified with an asterisk(*) on Forms D-491, 1A – 6C and the following BMS2 Items:

6A04	County/Municipality Boundary	6A44	Fracture Critical Group #
5C30	School Bus Indicator	6A45-6A48	FCM Criticality Rating Factor
5C32	Public Trans Indicator	VD14	Abutment Type
FR06	# Electrified Tracks	VD15	Abutment Foundation Type
FR03	Service Status of Railroad	VD16	Pier Type
FR05	AAR Number	VD17	Pier Foundation Type
FR04	Rail [Trail] Milepost	5C01	Name of Stream (for bridges also over water)
6C10	Hwy System	VP03	Spec Restrictive Posting
6C11	State Network	VP04	Posted Load Limits
6C24	Vertical Clearance Sign	VP01	1st and Last Date Posted
VD19	Length of Culvert	VP01	Date of Bridge Closure
5B01	Bridge Deck Type	VP06	Reason for Posting
SP03 SP04	Spans, Number & Length		

Note: Only applicable applicable inventory items need be coded. All data submitted will be stored in BMS2. Owners are encouraged to collect and submit all inventory information they have available.

Minimum Required Inspection Information:

1. Minimum inspection data includes all BMS2 Items identified with an asterisk(*) on Forms D-491E and the following BMS2 Items:

4A11	Underclearance Appraisal	
4A03-4A06	Safety Features	
7A09	Next Inspection Frequency	
7A03	Type of Inspection	
7A05	[Current] Inspection By	
7A05	Consultant Name	
6B24	Agency Hiring Consultant	
6B40	Deck Wearing Surface Condition	
6B36	Paint Condition	
3A	Items 3A04-3A08	
6A, 7A	Items 6A44 and 7A01	For Fracture Critical Members
IN, IU	All IN and IU items except IN22 and IN23	For bridges also over water

2. The following BMS2 inspection items are <u>not required</u> for non-highway bridges as they relate more to the planning and programming:

4A09	Structural Condition Appraisal	Not required
4A10	Deck Geometry Appraisal	Not required
4A02	Approach Alignment Appraisal	Not required
4B03	Bridge Capacity Appraisal	Not required

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APPENDIX IP 01-J

Guidelines for Preparation of Safety Inspection Agreements

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Publication 238 (2021 Edition), Appendix IP 01-J
Guidelines for Preparation of Safety Inspection Agreements

The following guidelines are to assist in the development of engineering agreements for bridge inspection services using the General Scope of Work (SOW) for Safety Inspection of State and Local Bridges and Tunnels in Appendices IP 01-F and IP 01-G of the Department's Bridge Safety Inspection Manual, Publication 238.

A. Costs for District Estimates and Price Proposals

1. The bridge inspection work consists of field work and office work. The District's estimate of costs and the consultant's Price Proposal are to provide the crew hours and costs for field and office work for each major task, and within each major task then subdivide into crew hours and rate of pay by classification of personnel, where applicable. Bridge inspection work consists of:

   a. Professional Services (Direct Payroll Costs)
   b. Direct Costs other Than Payroll
   c. Non-professional Services (Indirect Costs)

2. Field costs include any required cleaning and gauging of members, engineering, and any other incidental items. Office costs include structural analysis, preparation of drawings and reports, and any other incidental items.

3. If a bridge consists of more than one structure type (i.e., main span truss, approach spans-multi-stringer system), show costs for each structure type.

4. For non-professional services such as core borings, rigging, crane rental, traffic control, and laboratory testing, follow the procedures in the latest version of PennDOT Publication 93, Policy and Procedures for the Administration of Consultant Agreements.

5. For professional services such as materials sampling and testing, etc., include copies of the proposals from sub-consultant, with the prime proposal.

(For more details, refer to Publication 93.)

B. Work Categories

1. An example of Work Categories is shown in Table 1 at the end of Appendix IP 01-F of Publication 238.

   For the following Types of Inspection Work, Initial Inspections, Routine Inspections, Closed Bridge Inspections and Load Ratings, use the standardized categories of work as shown on Table 1 (see above paragraph). The standardized categories are to be used on all agreements to assist in review of agreements and for inspection programming.

   The Districts may further subdivide these standard work categories if desired. Examples could include A1s to indicate steel stringers, A1P for prestressed girders. However, the first two digits of standard categories must be maintained.

   For Partial/Interim inspections, see next section.

C. Partial/Interim Inspections

1. If Method of Payment is **Cost Per Unit of Work** (CPUW), the following mechanism to allow quick agreement on the work required and basis of payment:

   a. Establish a series of interim inspection types in the Agreement with work categories with a specified number of crew hours to be paid. For example:

      Partial/Interim Inspections
      Work Category I1 - 2 crew hours
      Work Category I2 - 4 crew hours
      Work Category I3 - 6 crew hours
      Work Category I4 - 8 crew hours
      Work Category I5 - 10 crew hours
      Work Category I6 - 12 crew hours
      Work Category I7 - 14 crew hours

(The above types are for example only and should be tailored for the specific bridges in your Agreement. When developing the cost for Partial/Interim inspections the Profit shall be limited to 10% of the direct and indirect Payroll costs.)

b. When an interim inspection is needed, the District and consultant must first reach agreement on the SOW for that inspection. Then the Work Category appropriate to that inspection is agreed upon and the work authorized.

   In the request letter, the consultant outlines the scope for the interim inspection work at each bridge along with the appropriate work category for District review and authorization.

2. If **COST PLUS FIXED FEE** method of payment is used, a number of Partial/Interim inspections may be set aside in a separate part of the agreement for the purpose of Partial/Interim inspections. Again, the consultant would request authorization via letter and the District would issue the Notice to Proceed for the agreed upon Partial/Interim inspections.

3. Note:

   a. The interim inspections must always be recorded on inspection forms and the data entered into BMS2. Ensure that the report format and requirements are established before authorization.

   b. Partial/interim inspections where data need not be recorded in BMS2 or those that require less than 2 crew hours probably fall under the category of owner's responsibilities and not the NBIS program.

4. For bridges with a straightforward and uncomplicated structure framing plan where interim inspections (such as for a posted stringer bridge) are needed, and if the scope and work category can be established easily, the authorization can be requested and granted through the agreement SOW and list of inspections.

5. More extensive inspections than those above may be better handled under Routine NBIS inspections or Supplemental Inspections.

6. Partial/Interim inspections can be used for flood inspections. Common sense must be used to avoid mis-use of federal funding. Mere water depth checks and other cursory inspections do not fall under NBIS.

D. Supplemental Inspections

For both CPUW and Cost Plus Fixed Fee agreements, the scope and crew hours for Supplemental Inspections need to be established at time of SOW or must be accomplished through a supplemental engineering agreement.

E. List of Bridges and Special Requirements

1. Provide list of bridges by S.R. ID with scope/category of work for each bridge.

   A sample of such a list for a CPUW agreement is attached to Publication 238 Appendix IP 01-F as Exhibit 1. Please note that, on the sample, authorization has been requested for interim inspections on certain bridges and for critical deficiency meetings. Interims/meetings may also be added later on an as needed basis. Specify a list format to meet your needs.

2. Add special instructions for work requirements, project management, emergency communications, M&P Traffic, etc. here. The intent of the SOW should not be altered, but the means/methods of accomplishing that work may be tailored to suit the needs of the various parties.

APPENDIX IP 02-A

Scour Critical Bridge Monitoring
Field Manual And
High Water Inspection Weekly Report Form

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SCOUR CRITICAL BRIDGE MONITORING FIELD MANUAL

PROCEDURES FOR MONITORING SCOUR CRITICAL BRIDGES DURING FLOOD EVENTS

July 2009
(Revised 2021)

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Scour Critical Bridge Monitoring Field Manual

1.1 Introduction

Pennsylvania has numerous highway bridges that have been identified as Scour Critical, meaning the foundations are at risk of becoming unstable due to potential scour. These Scour Critical bridges will require corrective action, monitoring, or closure, when necessary, in order to protect the traveling public. This manual is intended as a reference for use by field personnel performing monitoring during flood events.

The monitoring personnel for Scour Critical bridges have a critical role with significant responsibilities. As the personnel assigned to specific bridges, the monitoring personnel assess the field conditions during a flood event. To properly perform the assessment, personnel must understand the general nature of scour, know what to look for in the field and properly execute notification processes and a bridge closure should a serious problem be discovered. Serious problems can include overtopping, movement or settlement of the bridge, erosion of approach roadways or stream banks adjacent to the bridge, or heavy debris buildup on the bridge supports.

Section 2 explains basic scour concepts and definitions. Section 3 describes the content of Scour Plans of Action (POA) for Scour Critical bridges. A Scour POA provides important information including background data for the bridge, monitoring recommendations, proposed and completed scour repairs, and scour issues previously identified from bridge inspections. Section 4 describes monitoring and reporting procedures for Scour Critical bridges and associated bridge closures. Section 5 describes emergency procedures.

2.1 Definitions and Basic Scour Concepts

Personnel responsible for monitoring Scour Critical bridges should have a basic understanding of scour concepts. This section contains definitions, types of scour, and the factors that influence scour potential. The five key items defined below are Local Scour, Pressure Flow, Scour Critical Bridge, Scour Plan of Action and Significant Flood Event.

2.1.1 Definitions

The following is a list of scour related terms and their definitions in alphabetical order:

Aggradation	General and progressive buildup of the longitudinal profile of a channel bed due to sediment deposition
Alluvium	Loose material deposited in the streambed by stream flow
Bank	The side slopes of a channel between which the flow is normally confined
BMS2	Bridge Management System 2 – Stores bridge inventory and inspection data for all PennDOT owned bridges 8 feet span and greater and for locally-owned bridges 20 feet span and greater
Bridge Watch	Web-based system that tracks multiple data sources, provides real-time precipitation data and notifications for Scour Critical bridges statewide. System also stores post flood data.
Channel	The bed and banks that confine the flow of surface water in a stream

Contraction	The effect of constricting channel flow by a reduction in the waterway width such as that caused by a bridge opening that is narrower than the normal channel width or flood plain
Contraction Scour	Scour in a channel or on a flood plain that is not localized at a pier, abutment, or other obstruction to flow. In a channel, contraction scour usually affects all or most of the channel width and is caused by a reduction in the waterway opening.
Countermeasure	A measure intended to prevent, delay or reduce the severity of scour
Debris	Floating or submerged material, such as logs or trash, transported by a stream
Degradation	A general and progressive lowering of the channel bed due to scour
Erosion	The wearing away of soil particles on the land surface or along channel banks by flowing water
Flood Plain	A nearly flat, alluvial lowland bordering a stream, that is subject to inundation by floods
Lateral Migration	Horizontal movement of the channel position due to bank erosion on one side with simultaneous build-up on the other
Local Scour	**Scour in a channel or on a flood plain that is localized at a pier or abutment or other flow obstruction. Local scour, if unarrested, may result in the exposure or undermining of a footing or foundation.**
Overbank Flow	Water movement over top of the banks where water flows into the flood plain
Pressure Flow	**Where flows through the bridge opening is contracted vertically, submerging or partially submerging the bridge load carrying members and creating increased hydraulic pressure. In other words, water is flowing against the beams of a typical bridge or truss, or the slab of a slab bridge, or the opening of a culvert is completely under water.**
RCRS	Road Condition Reporting System: Reports active road closures, lane restrictions, and winter road conditions throughout the state of Pennsylvania. State owned highways are reported on in this system. Turnpikes, toll roads and bridges, and other non-state maintained roads are not included. Bridges closed due to flood damage are reported as a “Bridge Outage”. Bridges closed due to overtopping, pressure flow, or debris buildup can be reported as a “Bridge Precautionary Closure”.
Riprap	Rock of a specified gradation which has been engineered and placed to protect a structure or embankment from scour
Scour	The result of the erosive action of running water that excavates and carries away material from a channel bed

Scour Critical Bridge	**A bridge determined to be Scour Critical through engineering calculations or by observation of certain field conditions**
Scour Plan of Action	**A document for each identified Scour Critical Bridge that provides a single point reference of the scour inspection information, flood monitoring program, and a schedule for countermeasures to make a bridge safe from scour and stream stability problems.**
Significant flood event	**A precipitation-based stream response of a magnitude which could endanger the safety of the travelling public because of significant risk of bridge failure due to scour**
Streambank erosion	Removal of soil or other particles from a bank surface due primarily to water action
Undermining	The erosion or scouring of bed material from beneath the structure foundation or footings

2.1.2 Types of Scour

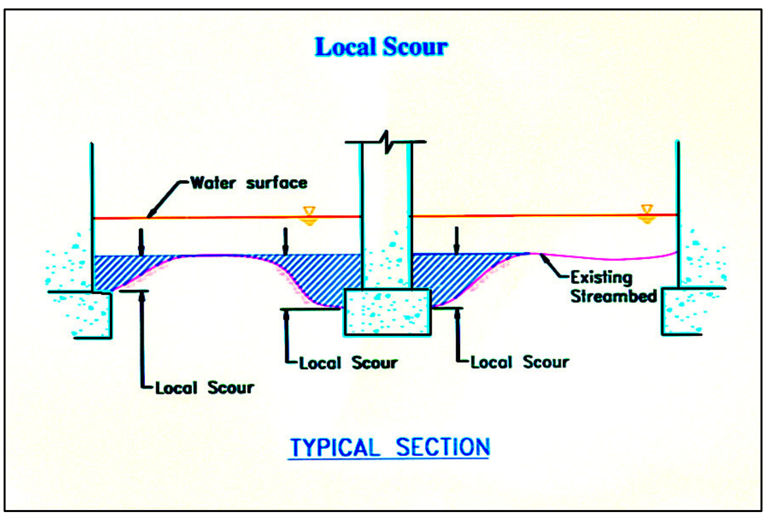
Scour is the result of erosion due to flowing water, removing sediment from the streambed and banks of streams and from around or under supports of bridges. Different types of streambed materials scour at different rates.

Streambed material and streamflow rates are important factors when assessing the scourability at a bridge. Examples of different streambed materials and their scour rates follow:

- Sand and gravel – hours
- Cohesive soils (clay) – days
- Glacial till, sandstone and shale – months
- Limestone – years
- Dense granite – centuries

Scour at bridges can be categorized by one of three types:

1. Local scour at piers and abutments (most common)
2. General or Contraction scour
3. Long term aggradation and degradation



Local scour is scour in a channel or flood plain that is localized at an obstruction. Local scour occurs at piers and abutments and is caused by turbulence at the substructure units creating a localized scour hole which can eventually remove material from under the footing which is known as undermining. The larger the substructure unit width, the greater the turbulence can become which can result in a greater depth of scour. Flow velocity and water depth are also contributing factors to scour depth. Debris accumulation at a substructure unit can increase the apparent size of the unit and lead to more turbulent flow resulting in increased scour.

Contraction scour is a type of general scour caused by a constriction in a channel or flood plain and generally affects the entire channel width. Contraction scour at a bridge is the result of the narrowing of the width of flow as it passes through the bridge opening which creates an acceleration of the flow and results in the removal of streambed material under the bridge and immediately upstream and downstream from the bridge.

General scour is a lowering of the channel bed over time. General scour is different from long-term degradation in that general scour may be cyclic and/or related to the passing of a flood.

Long term aggradation and degradation is the general rise of the streambed by increased deposits of streambed material (aggradation) or uniform lowering of the streambed by scour over a long period of time (degradation).

2.1.3 Lateral Migration

In addition to the three types of scour described above, lateral migration (horizontal change in waterway alignment) of the stream should be assessed when evaluating scour at bridges. Lateral migration of the main channel often occurs naturally, but can also be induced or magnified by flooding. A channel moving laterally may affect the stability of piers along the channel bank, can cause erosion behind abutments, damage the approach roadway embankments, or increase the potential for scour by changing the flow direction at piers and abutments.

2.2 Tips to Remember Concerning Scour

- Flow Depth – As the flow depth increases, the scour rate may increase.
- Flow Velocity - Faster flow produces deeper scour.
- Pier Width – Wider piers create more turbulence than narrow piers and result in increased local scour depths. Wider piers also contribute to an increase in contraction scour.
- Flood Debris – Debris lodged at a substructure unit will increase the obstructed width of the unit and change its shape. This can result in additional contraction scour as well as additional local scour. The additional turbulence caused by debris can increase scour damage at bridges.
- Flow Alignment – When upstream flow approaches a structure at an angle toward the bridge substructure units, the development of both local and contraction scour can increase rapidly.
- Floodplain – Low banks allow high flows to extend onto the floodplain. When overbank flow is forced back into the main channel or through a bridge opening, contraction scour can occur.
- Pressure Flow – Pressure flow begins when flowing water fills the entire bridge opening, submerging or partially submerging the bridge load carrying members. It can greatly increase velocity and accelerate scour rates.
- Countermeasures - Riprap and other countermeasures may protect a substructure unit from failure due to scour.

3.1 Scour Plans of Action (POA) for Scour Critical Bridges

Each scour-critical bridge in Pennsylvania must have an associated Scour Plan of Action (POA) developed. The Scour POA shall include the following:

- General information about the bridge including inventory data (i.e. bridge type, foundation type, location, etc.), scour information, and select inspection data condition ratings.
- The plan of action category and procedures including the monitoring program, scour countermeasures, closure indicators, and bridge specific information.
- Contact information.
- Other pertinent information such as a plan view scour sketch, stream cross-sections, elevation views, and photos.

The elements contained in a Scour POA for a given bridge will vary slightly depending on the Scour Critical Bridge Indicator (SCBI) code. Pennsylvania's scour susceptible bridges are subdivided into four categories. Categories A through C are defined as Scour Critical and are described below.

Category A These bridges have an SCBI code (BMS2 Item 4A08) of 2 OR an Observed Scour Rating (BMS2 Item IN03) of 3 or less. Field conditions indicate that extensive scour, including undermining, has occurred and the affected substructure units are at high risk of becoming unstable due to the potential for scour. Category A bridges present a significant safety hazard under high water conditions since additional undermining of the substructure could cause a partial failure or collapse of the bridge in a short amount of time.

The Scour POA for Category A bridges includes monitoring these bridges for distress during significant flood events and for completing a flood monitoring log with entries on the log for each visit to the bridge. Monitoring is initiated based upon notification of bridge outage/closure due to flooding from RCRS, Bridge Watch, County Maintenance, a 911 center, or the police.

Bridges in this category are to be closed at such time as the bridge approach roadway is submerged, or the bridge goes into pressure flow, whichever occurs first. If it is deemed necessary to keep the bridge open while it is in pressure flow then the bridge must be continuously monitored (i.e. placed under a 24/7 watch) in order to assure its safety for use. If it cannot be continuously monitored while under pressure flow, then it must be closed.

Category B These bridges have an SCBI code of 3 AND an Observed Scour Rating of 4. Category B bridges are Scour Critical, and the foundation is at medium risk of becoming unstable due to the potential for scour below or within limits of the spread footing or pile tips. In addition, field observations identified one or more of the following: serious scour, erodible streambed material, poor waterway opening and/or poor stream alignment.

The Scour POA for Category B bridges includes a recommendation for monitoring these bridges during significant flood events whenever possible, especially those bridges located on the Interstates and the National Highway System (NHS).

Category C These bridges have an SCBI code of 3 AND an Observed Scour Rating of 5 through 7. Category C bridges are scour critical, and the foundation is at low risk of becoming unstable due to the potential for scour below or within limits of the spread footing or pile tips. In addition, field observations identified one or more of the following: advanced scour hole (i.e. very slight undermining), erodible streambed material, and/or increased risk of debris blockage.

The Scour POA for Category C bridges includes a recommendation for monitoring these bridges during significant flood events whenever possible, especially those bridges located on the Interstates and the National Highway System (NHS).

4.1 Monitoring Procedures

As bridge flood problems and/or closures of bridges are reported by Bridge Watch, the Traffic Management Center (TMC), County Maintenance organizations , 911 Centers, or police departments, and as the status of closings are reported through the RCRS as a “Bridge Precaution”, “Bridge Outage” or “Flooding”, Department personnel will need to initiate monitoring of scour critical bridges. Step-by-step bridge monitoring procedures are listed in Publication 23, Chapter 9.11.

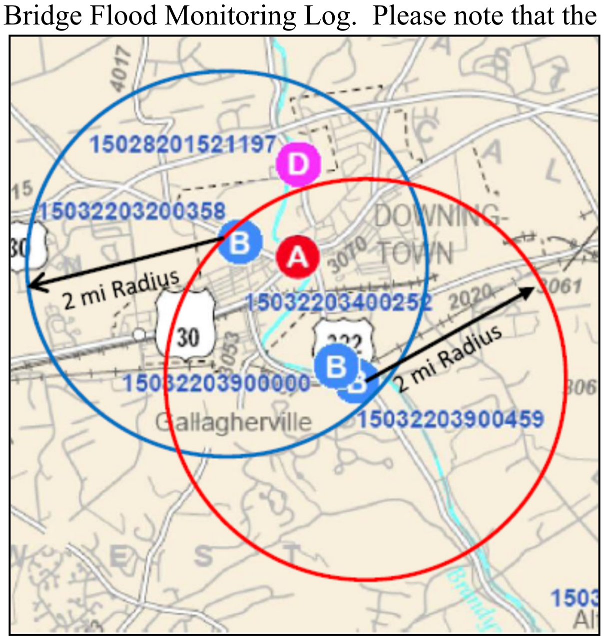
The Districts and counties are to maintain lists of Scour Critical bridges that are to be monitored during significant flood events. These lists are to be generated from a standard Crystal Report titled “Scour Critical Bridge Category List” that is available on Crystal Enterprise. The Districts are to re-generate these lists on a monthly basis and are to supply them to the counties. They are also added to the Bridge Watch program. Districts and counties must use these lists and Bridge Watch as the primary sources to determine which bridges are to be monitored.

GIS maps showing the locations of all Scour Critical bridges in categories A, B and C as well as non-Scour Critical bridges in Category D will be updated by Central Office and provided to the District bridge units every month or can be found in Bridge Watch. Districts and counties can use these maps to locate the bridges to be monitored.

All Category A bridges within the vicinity of the reported bridge flood problems and/or closures are to be monitored. Category B and C bridges should also be monitored depending on the severity of flooding and at the direction of the District Bridge Engineer or the Highway Maintenance Manager. Site visit Scour Critical bridges using one of two (2) methods.

Method 1 is the current method of monitoring all bridges within a minimum 2-mile radius of the Bridge Watch notification or RCRS reported bridge closure in order to determine whether those bridges meet the requirements for closure per the Bridge Flood Monitoring Log. The visits to scour critical bridges are to be systematically expanded in 2-mile increments beyond any bridge where closure is required. An example of this is as follows:

1) RCRS bridge closure reported as bridge 15032203900459 (a Category B bridge). A site visit to all scour critical bridges within a 2-mile radius of the RCRS reported closure (represented by the red circle) is conducted to determine whether those bridges meet the requirements for closure per the Bridge Flood Monitoring Log. Please note that the Scour Critical Bridge Maps have a scale of 1 inch = 1 mile when printed at full scale. Therefore, a 2-mile radius is anything within 2 inches as measured on the map.



2) Bridge 15032203200358 (northwest of the first reported closure) is determined to meet the requirements for closure per the Bridge Flood Monitoring Log. A two-mile radius from this bridge is to be added (represented by the blue circle). The visits to scour critical bridges are to be systematically expanded in 2-mile increments beyond any scour critical bridge where closure is required.

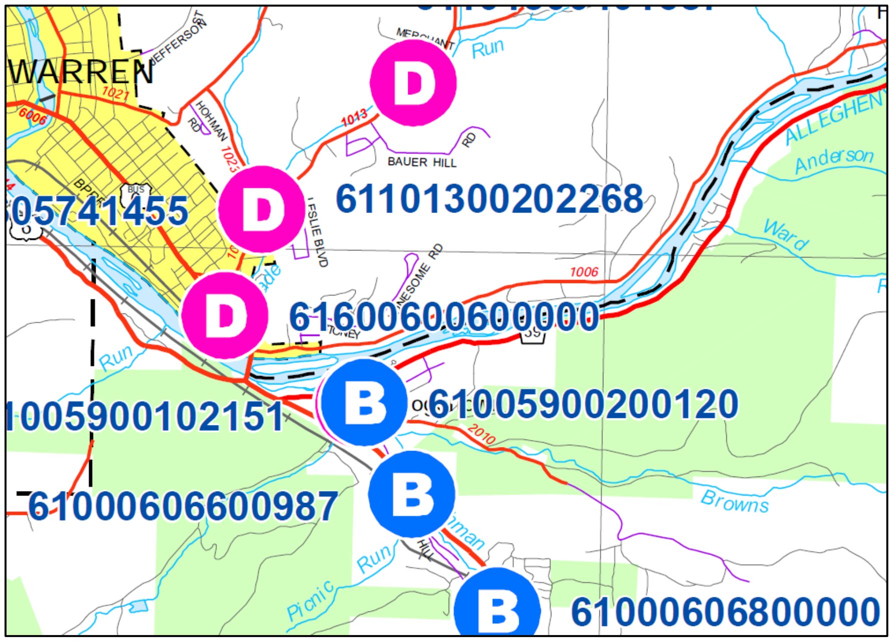
3) No additional bridges are found that meet the requirements for closure per the Bridge Flood Monitoring Log. All Category A bridges within the red and blue circles are to be monitored. Category B and C bridges should

also be monitored depending on the severity of flooding and at the direction of the District Bridge Engineer or Highway Maintenance Manager.

Method 2 is monitoring all bridges within the same drainage basin of the Bridge Watch notification or RCRS reported bridge closure in order to determine whether those bridges meet the requirements for closure per the Bridge Flood Monitoring Log. An example of this is as follows:

First bridge closure reported as bridge 61000606600987 (a Category B bridge) reported through a NEXRAD Bridge Watch alert (see sketch below). A site visit to all scour critical bridges within the same drainage basin of the Bridge Watch alert is conducted to determine whether those bridges meet the requirements for closure. Drainage Basin is highlighted in blue.

Bridge 61005900200120 (northwest of the first reported closure) and 61000606800000 (southeast of the first reported closure) are the only scour critical bridges in the same drainage basin. They are monitored according to the monitoring schedule in Publication 238 and Publication 23. No additional bridges outside of the drainage basin are required for monitoring.



The decision to perform monitoring of Category B and C bridges is to be coordinated between the Highway Maintenance Manager and the District Bridge Engineer and is to be based on the reported severity of flooding from monitoring personnel and the availability of adequate personnel to do so. Category A bridges are recommended to be monitored at a frequency of at least once every 4 hours. Category B and C bridges, when monitoring is directed, are recommended to be visited at a frequency of at least once every 12 hours for Category B and 24 hours for Category C.

A Bridge Flood Monitoring Log is to be filled out for each Category A bridge that is monitored. The log is to be updated at each visit to the bridge. Any Category A bridge located on the Interstate system must be monitored without exception and a Bridge Flood Monitoring Log must be filled out at each visit. The monitoring log is very brief and will require minimal effort to maintain. Detailed instructions are attached to the monitoring log and include trigger mechanisms for the need to close the bridge based on the observations logged on the sheet. See Appendix B of this manual for a copy of the Bridge Flood Monitoring Log and instructions for its use.

The personnel performing flood monitoring should be focused on looking for signs of any bridge distress during monitoring efforts. Typical examples include, but are not limited to:

- Overtopping of the bridge deck or approach roadway
- Pressure flow at the bridge (the bottom of superstructure mostly or fully submerged)
- Vertical or horizontal displacement of the superstructure or substructure
- Excessive horizontal or vertical separation at bridge deck joints
- Visible damage to the bridge deck, superstructure, or substructure

- Sinkholes, settlement or erosion in the roadway behind the abutments
- Heavy debris buildup on the superstructure or substructure

If signs of structural distress are apparent at any time, the monitoring personnel should initiate a bridge closure and should avoid getting on the bridge if at all possible. Once a bridge is closed, monitoring of that bridge no longer needs to be performed. Once they are closed, scour critical bridges must not be re-opened until inspected and approval to re-open is received from the District Bridge Engineer.

4.2 Reporting

Bridge closures are to be reported by the counties using the RCRS and Bridge Watch. RCRS reports all active bridge and roadway closures. Bridges that have been closed as a precaution, such as those that have overtopped or are experiencing pressure flow, are to be reported in RCRS with a "Cause" description of "Bridge Precautionary Closure". Those bridges closed due to scour failure are to be reported in RCRS with a "Cause" description of "Bridge Outage". Note that approach roadway overtopping may occur prior to bridge pressure flow. In these instances, the "Cause" description may not indicate that a Bridge has been closed. Bridge Watch reports scour critical bridge issues. Bridges closed in Bridge Watch should select the appropriate closure option.

- During flood events:
  - Per Publication 23, Ch 9.11, County Managers are to report to the District Bridge Engineer by phone or email on a daily basis. Counties may now use Bridge Watch to update the District Bridge Engineer.
  - District Bridge Engineers are to report all counties where active flood monitoring is occurring to the Chief Bridge Engineer on a daily basis. If bridges are reported in Bridge Watch in real time, then this satisfies this requirement.
- After flood events:
  - Highway Maintenance Managers will assemble and submit monitoring logs per Publication 23, Ch 9.11. These logs may be scanned and submitted electronically. Highway Maintenance Managers may upload these logs to Bridge Watch, or monitor bridges directly in Bridge Watch from a desktop or using the mobile app in lieu of monitoring logs and weekly submittals. Highway Maintenance Manager will have the authority to add local partners as users in Bridge Watch.
  - Using Bridge Watch, the information reported by the County Managers, information reported in RCRS for bridge closures, and rainfall accumulation data, the District Bridge Unit will screen and prioritize the bridges to receive post-flood inspections by bridge inspectors. Scour Critical bridge lists, monitoring data from the counties and Scour POA forms are to be referenced for this effort.
  - District Bridge Engineers are to submit weekly status reports to the BIS identifying the bridges monitored and the inspection results of bridges inspected following flood events. Districts may use Bridge Watch for all reporting in real time in lieu of status reports.

5.1 Emergency Procedures

Bridge closures will be the primary course of action taken if site conditions present a safety hazard to vehicular traffic.

5.1.1 Bridge Closures

During flood events, monitoring personnel may decide that a bridge closure is necessary if signs of bridge distress noted in Section 4.1 are observed. If the monitoring personnel decide that a closure is necessary, take action immediately. The barriers for the closure and the detour signage are to be installed by PennDOT or local government maintenance forces. After the need for closure has been determined, the monitoring personnel must remain at the bridge site until the bridge closure crew or law enforcement arrives at the scene to take over. If the bridge becomes unsafe for traffic while personnel are waiting for a formal bridge closure, they should perform an emergency closure of the bridge by blocking the road with their vehicle and/or placing cones.

The Highway Maintenance Manager needs to assure that all concerned parties are notified that the bridge is closed. At a minimum, the Assistant District Bridge Engineer for Inspection, the District Bridge Engineer, the RCRS Coordinator and the appropriate law enforcement agencies, state and local, as well as emergency services are to be notified of all closures.

Once a bridge has been closed, it must remain closed until the flood has passed. As soon as possible after the flood, a flood inspection of the bridge foundations, substructure, and channel is to be conducted. For PennDOT-owned bridges the District Bridge Engineer has the authority to reopen the bridge to traffic once it has been assessed as structurally sound.

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APPENDIX A

Scour Plan of Action
(Sample)

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SCOUR CRITICAL BRIDGE - PLAN OF ACTION

1. General Information

Structure ID Number (5A01):	District, County, Place (5A04);(5A05);(5A06):		Inspection Date (7A01):
BRKEY (5A03):	Length (5B18): **25**	Facility Carried (5A08):	Feature Intersected (5A07):
Year Built (5A15): **1973**	Year Rebuilt (5A16): **0**	Structure Type (6A26-29): **21101 RC SLAB (SOLID)**	
Number of Spans: Appr (5B14): **0**	Main (5B11) : **1**	5A10 Lat:	5A11 Long:
Bridge ADT (5C10): **500**	Bridge ADTT (6C27): **25**	ADT Year (5C11): **2013**	BPN (6A19): **L - Local Net (Non-NHS)**
Substructure (1A02): **5**	Channel (1A05): **4**	Waterway Adequacy (1A06): **7**	

2. Scour Information

SCBI (4A08): 3	Source of SCBI Code (IU03): O	Minimum Obs. Scour Rating (IN03): **4**	SCBI Category: B

7A01 Inspection Date	5D02 Structure Unit	IN13 Foundation Type	IN03 Observed Scour Rating	IU27 SCBI CODE	IN18 Water Depth	IN24 Underwater Inspection Notes:
09/19/2019	FAB	P - Researched/unknown	4	3	2.0	4/2019 Inspection: No significant changes. Rock is noted along the entire abutment. Rock was previously noted to seem small and could be washed out during high water events, however no significant change is noted since the previous high water event. The toe is not exposed along the abutment. No UM/Scour is evident along the FAB.
09/19/2019	NAB	P - Researched/unknown	4	3	5.0	Infilling of stream bed material has decreased the length of footing exposure since the previous underwater inspection. The footing is now exposed for a length of 12.5' along the right (upstream) end of the breastwall and partially along the right wingwall. The top of the footing was located 3.9' below the current waterline and the maximum height of exposure measured 1.6'. No undermining was detected. The downstream half of the breastwall and left wingwall are lined with rock protection and the footing was not detected. The rock protection extends to 5.0' from the abutment. The concrete exhibits light scaling and a few hairline vertical cracks. The streambed in the vicinity of the element consists of silt, sand, gravel, cobbles and rock protection. Probing the streambed resulted in penetrations of up to 0.4'. Soundings indicate advanced scour at the element. The channel flow was parallel with the abutment.

3. Monitoring Program (During Event)

Monitor Category B bridges at a minimum of twelve (12) hour intervals. Bridge Watch and Scour Critical Bridge Maps may be used as a means for locating these bridges.

The Scour POA for Category B bridges includes a need for monitoring these bridges in flooded areas whenever possible, especially those bridges located on the Interstates and the National Highway System (NHS). The recommended frequency for monitoring is once every 12 hours. Note that a minimum of 2 visits are required and monitoring is no longer needed after the bridge is closed. Monitoring of a bridge may be discontinued when the water level is at least two feet below the bridge load carrying members and after it has been clearly observed that the flood waters are receding, i.e., at the time of the visit to the bridge, the water level is now lower than that observed at the previous visit.

Local owned bridges: The local owner is responsible for flood monitoring and shall coordinate with PennDOT's local bridge coordinator to determine the bridges requiring monitoring.

Note: Slight chance of overtopping bridge deck and roadway approaches

4. Post-Flood (After Event)

A post-flood damage inspection is to be performed after each significant flood event that is experienced in the watershed where this bridge is located. As a guide, the 50 year recurrence interval storm event may be used as a trigger for the need for inspection. If the bridge has been closed due to overtopping of the approach roadway or bridge, or due to pressure flow, then the bridge must be inspected for scour damage before being re-opened to traffic.

Local bridge owners shall coordinate with PennDOT's local bridge coordinator to coordinate the post-flood inspection effort.

5. Countermeasures

Any Proposed Maintenance listed below is to be installed in accordance with a schedule consistent with the Priority Level assigned. Proper completion of these maintenance items should protect the bridge from further scour damage or failure.

Proposed Maintenance

IM03 Action	IM05 Priority	IM06 Date Recomended	IM07 Status	IM08 Target Year
C745301-BKFL.SCOUR HOLE	3 - Add to Schedule	04/24/2003	0 - Work not planned	2018
B745301-CONST RCK PROTECT	2 - Priority	04/29/2013	0 - Work not planned	2018

Completed Maintenance

IM03 Action	IM14a Completion Date	IM18 Actual Quantity

6. Bridge Closure Plan

Scour Monitoring criteria for consideration of bridge closure:

- **Pressure flow at the bridge (the bottom of superstructure mostly or fully submerged in water)**
- **Water overtopping the bridge deck or approach roadway**
- **Excessive vertical tilt, settlement or horizontal movement of the superstructure or substructure**
- **Excessive horizontal or vertical separation at bridge deck joints**
- **Visible damage to the bridge deck, superstructure or substructure caused by flood waters or floating debris**
- **Sinkholes, settlement or erosion in the approach roadway or loss of roadway embankment**
- **Heavy debris accumulation at or on the bridge severely restricting water flow through the bridge**
- **Washout of rock protection near the bridge substructure that indicates severe scour of the bridge**

Maintenance Responsinility (5A20):03 - Town/Twp Hwy Agency   Owner (5A21): 03 - Town/Twp Hwy Agency

Contact Persons Information:

District Bridge Engineer, ACMM, CMM

Name: Phone: Email:

Local Bridge Coordinator

Name: Phone: Email:

Local Bridge Owner

Name: Phone: Email:

Criteria for re-opening the bridge: After scour inspection performed by Qualified CBSI Inspection Team Leader and approval by the District Bridge Engineer (State bridges) or the Local Owner (non-state bridges).

7. Attachments

Please indicate which materials are being submitted with this POA:

- ☐ Attachment A: Plan view scour sketch showing location of scour holes, undermining, debris, etc.
- ☐ Attachment B: Cross sections from current and previous inspection reports which includes substructure unit elevations showing existing streambed, foundation depth(s) and observed scour depths.
- ☐ Attachment C: Map showing detour route(s) (Optional)
- ☐ Attachment D: Photos (Optional)

8. Monitoring Log

SAFETY FIRST - DO NOT ENDANGER YOURSELF OR OTHERS WHILE MONITORING BRIDGES

DO NOT ENTER EITHER FLOWING OR STANDING FLOOD WATERS WHILE MONITORING SCOUR CRITICAL BRIDGES

GENERAL INSTRUCTIONS: Visually examine the bridge and approach roadway each time the bridge is visited. Also look at the upstream and downstream sides of the bridge and waterway channel. Circle the appropriate response for items inspected. Leave blank if not inspected. Circle **"N"** for no, none or no change in condition since beginning of flood monitoring. Circle **"Y"** for yes, when appropriate, based on the descriptions below. Provide a written explanation for a **"Y"** response in the **"Remarks"** section as to what was observed or has changed.

Should you believe that the bridge is becoming unsafe for any reason, immediately close the bridge. When a "Y" response has been circled, the bridge must be closed. If it is deemed necessary to keep a bridge open for emergency vehicle passage or for emergency evacuations, then the bridge must be monitored at all times (24/7).

In order to re-route emergency response vehicles after a bridge has been closed, immediately notify appropriate law enforcement, local emergency responders and county emergency communications center using a non-emergency phone number or pre-established alternate communications. AVOID DIRECTLY CALLING 911 UNLESS THERE IS AN ACTUAL EMERGENCY. Closed bridges may be reopened only after a post-flood bridge safety inspection has been completed by qualified bridge inspectors and only after approval by a professional engineer. Notify PennDOT district office municipal services or bridge inspection personnel of bridge closures whenever possible.

MONITORING PERSONNEL and TIME: Record name(s) of person and time of monitoring (circle "A" for AM or "P" for PM)

BRIDGE:

- **Pressure Flow** - Has the water level reached the bottom of the bridge beams or the bottom of the bridge deck?
- **Alignment** - Sight along bridge beams, railing, curb, etc., for horizontal misalignment. Check specifically at the joints in the bridge over the piers or at the abutments. If the joint is wider at one side of the bridge than at the other (difference of 1/2 inch or more), when movement of the bridge due to scour should be suspected and the bridge should be closed.
- **Settlement** - Sight along bridge beams, railing, curb, paint striping, etc., for vertical misalignment. Any noticeable dip at a pier or drop at an abutment indicates settlement is occurring and the bridge must be closed immediately.
- **Tilt** - Check the abutments and piers for plumb. If there is any noticeable tilt side-to-side or forward or back then the bridge should be closed immediately.

APPROACH ROADWAY:

- **Settlement** - Check approach pavement for settlement. Water piping through the approach fill can cause erosion under the approach pavement causing the pavement to settle. Does it appear that there is new settlement or are there holes in the pavement?
- **Embankment Erosion** - Check approach roadway embankment slopes, shoulders, and edge of pavement for erosion. Extend limits of inspection to cover sections of the roadway that are parallel to the stream. Does a washout exist on the roadway embankments or shoulders?

WATERWAY CHANNEL:

- **Debris Build-up** - Check the bridge waterway opening for accumulation of trees, branches or other debris that severely restricts the flow of water and creates strong pressure on the bridge.

SAFETY FIRST - DO NOT ENDANGER YOURSELF OR OTHERS WHILE MONITORING BRIDGES

File Scour Critical Bridge Monitoring Logs with other bridge inspection records at the municipality.
Monitoring Logs are subject to review by the Federal Highway Administration (FHWA).

Struct ID: Date:____/____/______

BRKEY:

			Bridge		Roadway		Channel
Monitoring Personnel	Time	AM or PM	Pressure Flow	Alignment / Settlement / Tilt	Settlement	Embankment Erosion	Debris Buildup
		A / P	Y / N	Y / N	Y / N	Y / N	Y / N
Remarks:							
		A / P	Y / N	Y / N	Y / N	Y / N	Y / N
Remarks:							
		A / P	Y / N	Y / N	Y / N	Y / N	Y / N
Remarks:							
		A / P	Y / N	Y / N	Y / N	Y / N	Y / N
Remarks:							
		A / P	Y / N	Y / N	Y / N	Y / N	Y / N
Remarks:							
		A / P	Y / N	Y / N	Y / N	Y / N	Y / N
Remarks:							
		A / P	Y / N	Y / N	Y / N	Y / N	Y / N
Remarks:							
		A / P	Y / N	Y / N	Y / N	Y / N	Y / N
Remarks:							
		A / P	Y / N	Y / N	Y / N	Y / N	Y / N
Remarks:							
		A / P	Y / N	Y / N	Y / N	Y / N	Y / N
Remarks:							
		A / P	Y / N	Y / N	Y / N	Y / N	Y / N
Remarks:							
		A / P	Y / N	Y / N	Y / N	Y / N	Y / N
Remarks:							

Bridge Closed: Date:____/____/______ Time:______:__________

APPENDIX B

Bridge Field Monitoring Log

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Bridge Flood Monitoring Log

SAFETY FIRST - DO NOT ENDANGER YOURSELF OR OTHERS WHILE MONITORING BRIDGES

File Scour Critical Bridge Monitoring Logs with other bridge inspection records at the municipality.
Monitoring Logs are subject to review by the Federal Highway Administration (FHWA).

Struct ID: BRKEY: Date:____/____/____

SR/SEG/OFF: County: Stream:

			Bridge		Roadway		Channel
Monitoring Personnel	Time	AM or PM	Pressure Flow	Alignment / Settlement / Tilt	Settlement	Embankment Erosion	Debris Buildup
		A / P	Y / N	Y / N	Y / N	Y / N	Y / N
Remarks:							
		A / P	Y / N	Y / N	Y / N	Y / N	Y / N
Remarks:							
		A / P	Y / N	Y / N	Y / N	Y / N	Y / N
Remarks:							
		A / P	Y / N	Y / N	Y / N	Y / N	Y / N
Remarks:							
		A / P	Y / N	Y / N	Y / N	Y / N	Y / N
Remarks:							
		A / P	Y / N	Y / N	Y / N	Y / N	Y / N
Remarks:							
		A / P	Y / N	Y / N	Y / N	Y / N	Y / N
Remarks:							
		A / P	Y / N	Y / N	Y / N	Y / N	Y / N
Remarks:							
		A / P	Y / N	Y / N	Y / N	Y / N	Y / N
Remarks:							
		A / P	Y / N	Y / N	Y / N	Y / N	Y / N
Remarks:							
		A / P	Y / N	Y / N	Y / N	Y / N	Y / N
Remarks:							
		A / P	Y / N	Y / N	Y / N	Y / N	Y / N
Remarks:							

Bridge Closed: Date:____/____/____ Time:____:____

Bridge Flood Monitoring Log Instructions

SAFETY FIRST - DO NOT ENDANGER YOURSELF OR OTHERS WHILE MONITORING BRIDGES

DO NOT ENTER EITHER FLOWING OR STANDING FLOOD WATERS WHILE MONITORING SCOUR CRITICAL BRIDGES

GENERAL INSTRUCTIONS: Visually examine the bridge and approach roadway each time the bridge is visited. Also look at the upstream and downstream sides of the bridge and waterway channel. Circle the appropriate response for items inspected. Leave blank if not inspected. Circle **"N"** for no, none or no change in condition since beginning of flood monitoring. Circle **"Y"** for yes, when appropriate, based on the descriptions below. Provide a written explanation for a **"Y"** response in the **"Remarks"** section as to what was observed or has changed.

Should you believe that the bridge is becoming unsafe for any reason, immediately close the bridge. When a "Y" response has been circled, the bridge must be closed. If it is deemed necessary to keep a bridge open for emergency vehicle passage or for emergency evacuations, then the bridge must be monitored at all times (24/7).

In order to re-route emergency response vehicles after a bridge has been closed, immediately notify appropriate law enforcement, local emergency responders and county emergency communications center using a non -emergency phone number or pre-established alternate communications. AVOID DIRECTLY CALLING 911 UNLESS THERE IS AN ACTUAL EMERGENCY. Closed bridges may be reopened only after a post-flood bridge safety inspection has been completed by qualified bridge inspectors and only after approval by a professional engineer. Notify PennDOT district office municipal services or bridge inspection personnel of bridge closures whenever possible.

MONITORING PERSONNEL and TIME: Record name(s) of person and time of monitoring (circle "A" for AM or "P" for PM)

BRIDGE:

- **Pressure Flow** - Has the water level reached the bottom of the bridge beams or the bottom of the bridge deck?
- **Alignment** - Sight along bridge beams, railing, curb, etc., for horizontal misalignment. Check specifically at the joints in the bridge over the piers or at the abutments. If the joint is wider at one side of the bridge than at the other (difference of 1/2 inch or more), when movement of the bridge due to scour should be suspected and the bridge should be closed.
- **Settlement** - Sight along bridge beams, railing, curb, paint striping, etc., for vertical misalignment. Any noticeable dip at a pier or drop at an abutment indicates settlement is occurring and the bridge must be closed immediately.
- **Tilt** - Check the abutments and piers for plumb. If there is any noticeable tilt side-to-side or forward or back then the bridge should be closed immediately.

APPROACH ROADWAY:

- **Settlement** - Check approach pavement for settlement. Water piping through the approach fill can cause erosion under the approach pavement causing the pavement to settle. Does it appear that there is new settlement or are there holes in the pavement?
- **Embankment Erosion** - Check approach roadway embankment slopes, shoulders, and edge of pavement for erosion. Extend limits of inspection to cover sections of the roadway that are parallel to the stream. Does a washout exist on the roadway embankments or shoulders?

WATERWAY CHANNEL:

- **Debris Build-up** - Check the bridge waterway opening for accumulation of trees, branches or other debris that severely restricts the flow of water and creates strong pressure on the bridge.

APPENDIX C

Sample Bridge Watch Monitoring Forms

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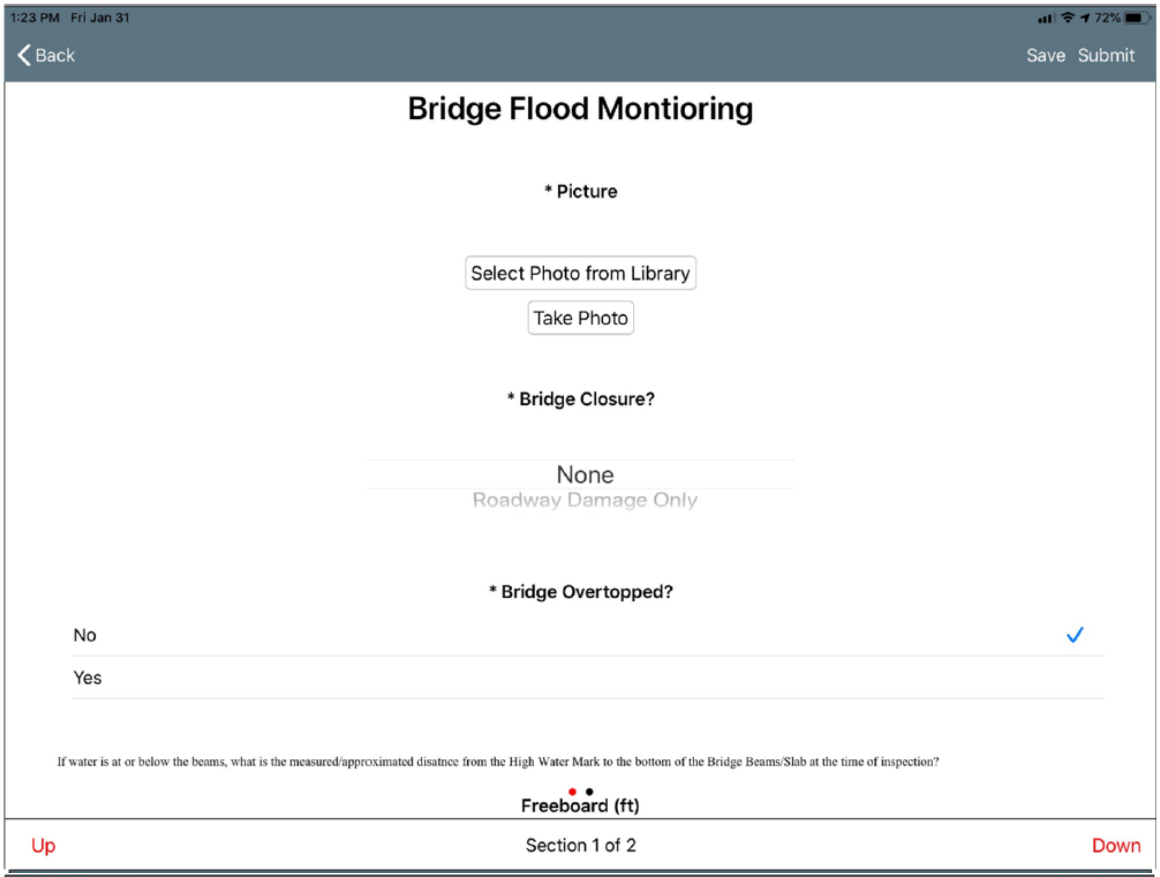
iPad Bridge Watch Monitoring Form



1:23 PM Fri Jan 31 72%

Back Save Submit

Bridge Flood Montioring

* Picture

Select Photo from Library

Take Photo

* Bridge Closure?

None

Roadway Damage Only

* Bridge Overtopped?

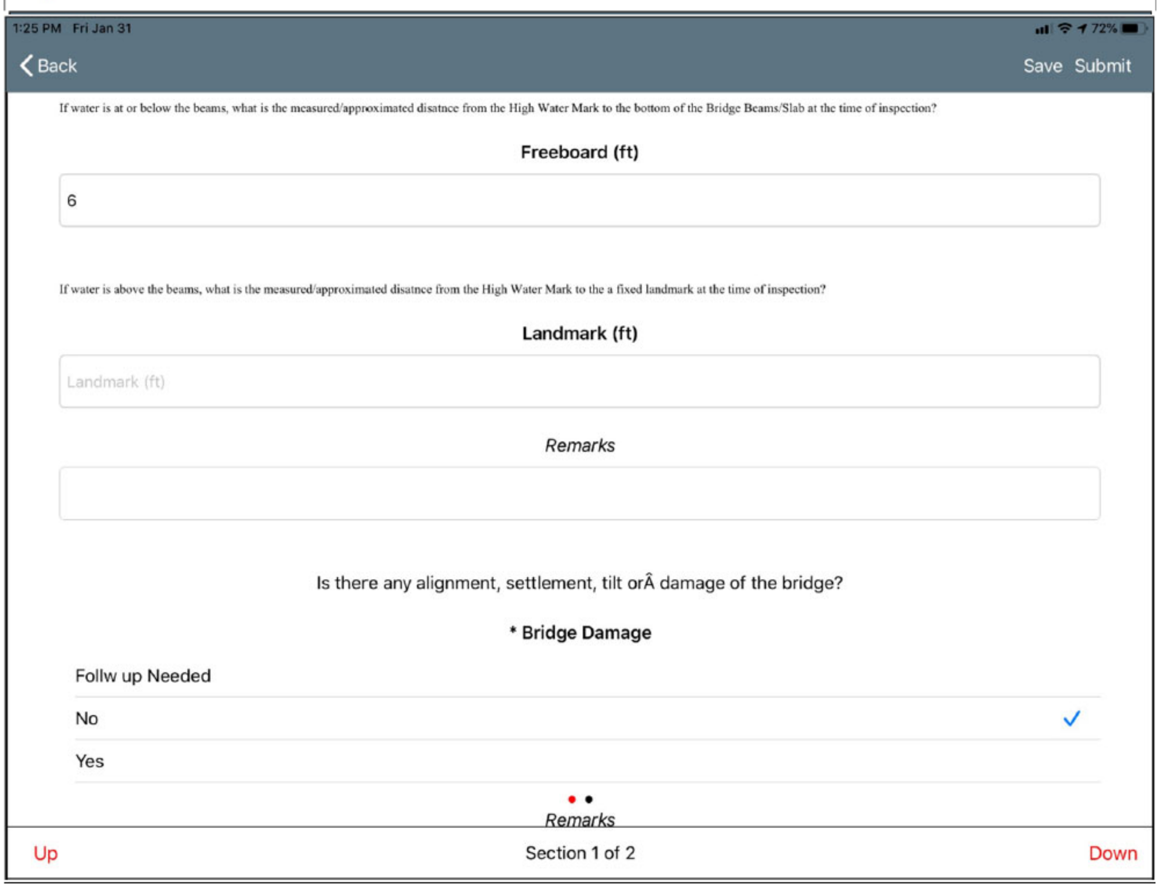
No ✓

Yes

If water is at or below the beams, what is the measured/approximated disatnce from the High Water Mark to the bottom of the Bridge Beams/Slab at the time of inspection?

Freeboard (ft)

Up Section 1 of 2 Down



1:25 PM Fri Jan 31 72%

Back Save Submit

If water is at or below the beams, what is the measured/approximated disatnce from the High Water Mark to the bottom of the Bridge Beams/Slab at the time of inspection?

Freeboard (ft)

6

If water is above the beams, what is the measured/approximated disatnce from the High Water Mark to the a fixed landmark at the time of inspection?

Landmark (ft)

Landmark (ft)

Remarks

Is there any alignment, settlement, tilt orÂ damage of the bridge?

* Bridge Damage

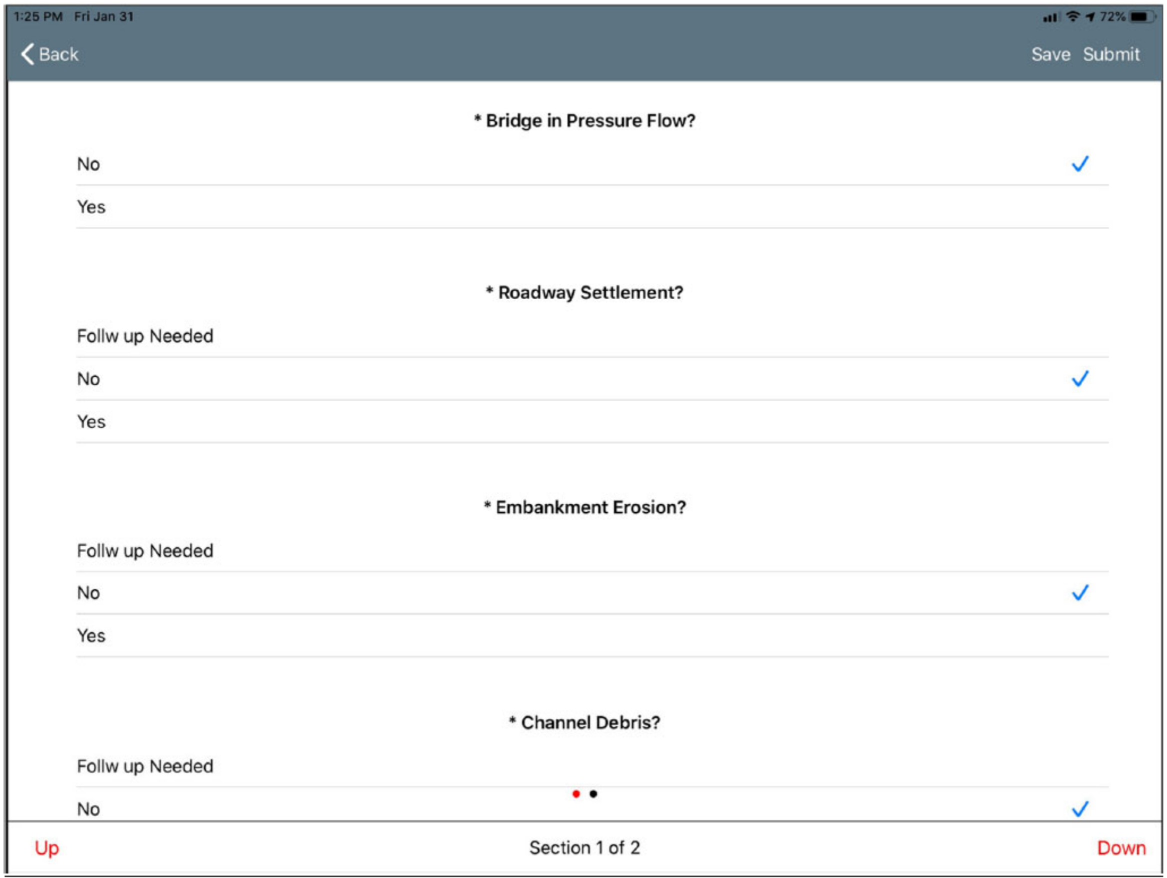
Follw up Needed

No ✓

Yes

Remarks

Up Section 1 of 2 Down


1:25 PM Fri Jan 31 72%

Back Save Submit

* Bridge in Pressure Flow?

No ✓

Yes

* Roadway Settlement?

Follw up Needed

No ✓

Yes

* Embankment Erosion?

Follw up Needed

No ✓

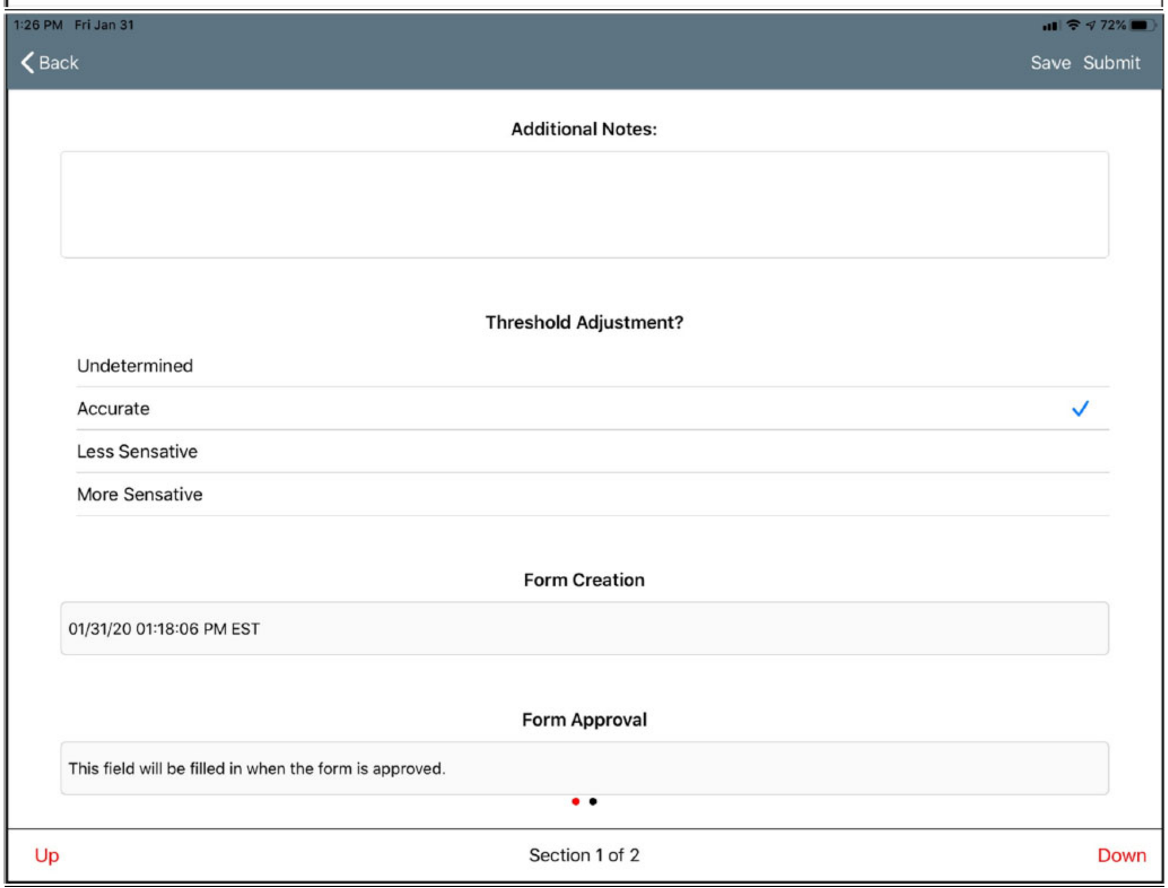
Yes

* Channel Debris?

Follw up Needed

No ✓

Up Section 1 of 2 Down


1:26 PM Fri Jan 31 72%

Back Save Submit

Additional Notes:

Threshold Adjustment?

Undetermined

Accurate ✓

Less Sensative

More Sensative

Form Creation

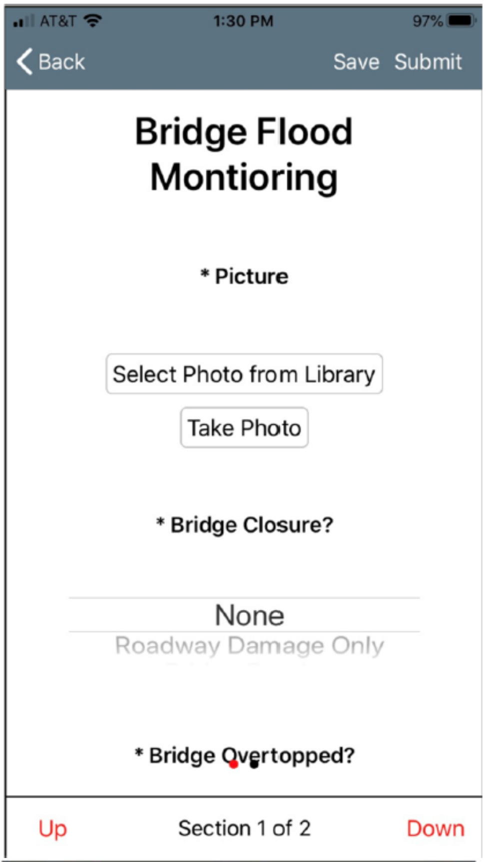
01/31/20 01:18:06 PM EST

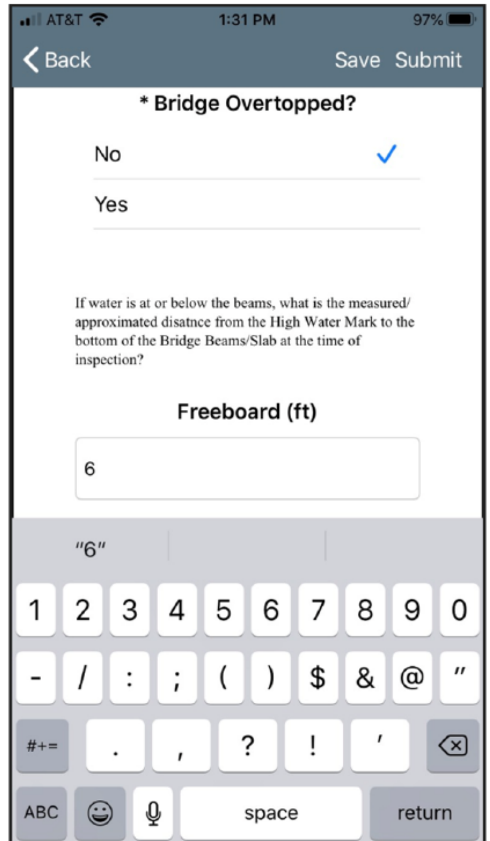
Form Approval

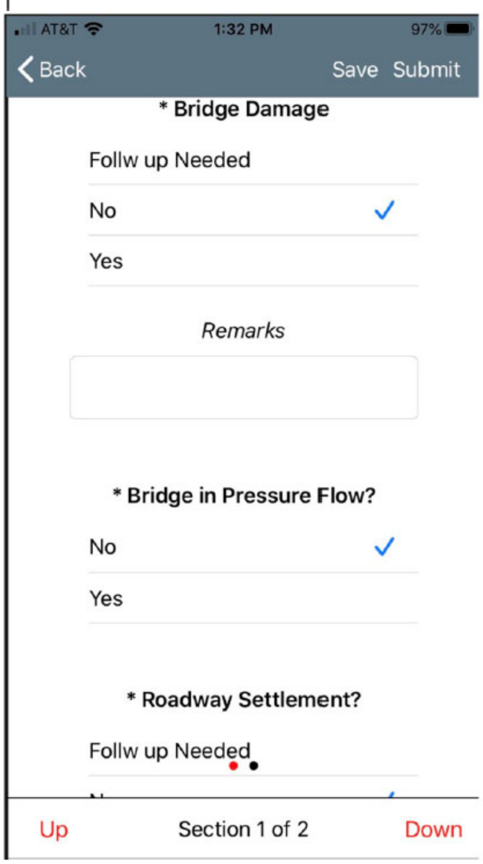
This field will be filled in when the form is approved.

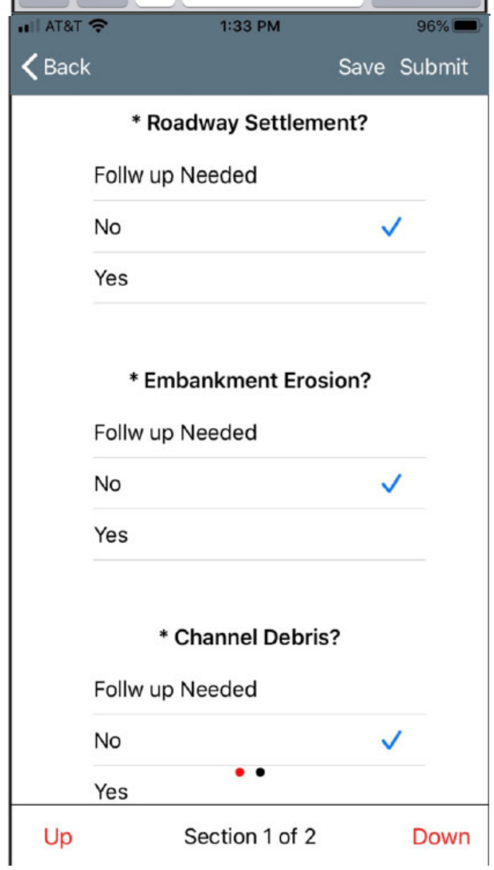
Up Section 1 of 2 Down

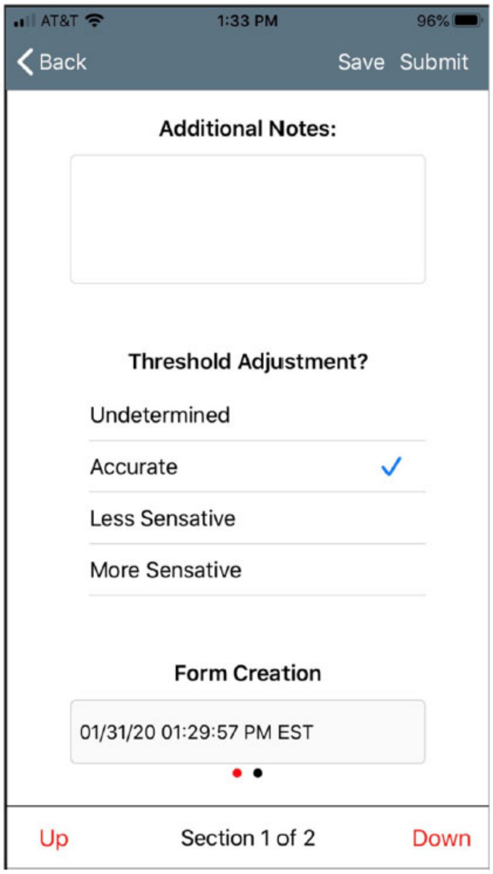
iPhone Bridge Watch Monitoring Form

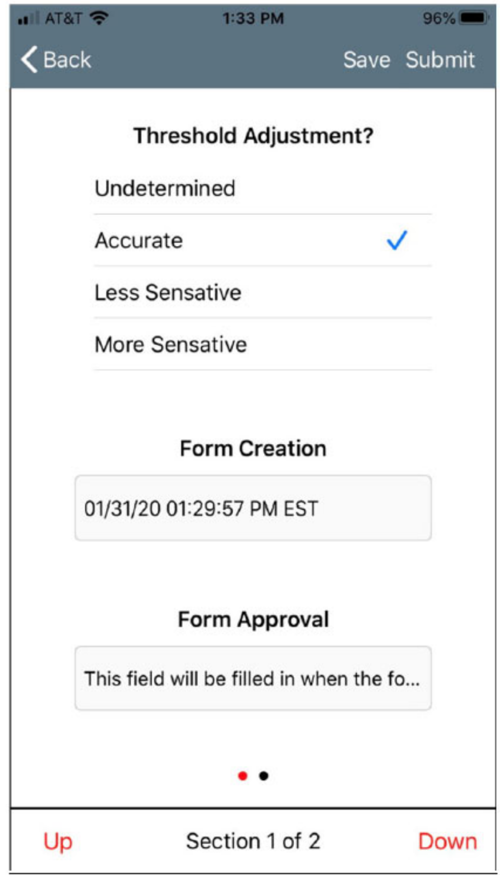









AT&T 1:33 PM 96%
Back
Save Submit
Additional Notes:
Threshold Adjustment?
Undetermined
Accurate
Less Sensative
More Sensative
Form Creation
01/31/20 01:29:57 PM EST
Up
Section 1 of 2
Down


AT&T 1:33 PM 96%
Back
Save Submit
Threshold Adjustment?
Undetermined
Accurate
Less Sensative
More Sensative
Form Creation
01/31/20 01:29:57 PM EST
Form Approval
This field will be filled in when the fo...
Up
Section 1 of 2
Down

Desktop Bridge Watch Monitoring Form

BridgeWatch | Pennsylvania Department of Transportation

Monitoring ▾ | Clear Form | Submit | Cancel | *Form Creation >> Form Approval >> Form A*

Form | File

Monitoring Form

Bridge Flood Montioring

*Picture — Select File

*Bridge Closure? — Bridge Caution ▾

*Bridge Overtopped? — (•) No ( ) Yes

If water is at or below the beams, what is the measured/approximated disatnce from the High Water Mark to the bottom of the Bridge Beams/Slab at the time of inspection?

Freeboard (ft) — 0

BridgeWatch | Pennsylvania Department of Transportation

Monitoring ▾ | Clear Form | Submit | Cancel | *Form Creation >> Form Approval >> Form A*

Form | File

Findings

* Is there any alignment, settlement, tilt or damage of the bridge?

Bridge Damage	(•) Follow up Needed ( ) No ( ) Yes
Remarks:	
*Bridge in Pressure Flow?	(•) No ( ) Yes
*Roadway Settlement?	(•) Follow up Needed ( ) No ( ) Yes
*Embankment Erosion?	(•) Follow up Needed ( ) No ( ) Yes
*Channel Debris?	(•) Follow up Needed ( ) No ( ) Yes
Additional Notes:	
Threshold Adjustment?	(•) Undetermined ( ) Accurate ( ) Less Sensitive ( ) More Sensitive
Form Creation	7/23/20 1:01:38 PM EDT
Last Revision	This field will be filled in when the form is submitted.
Form Approval	This field will be filled in when the form is approved.

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APPENDIX IP 02-B

BPR Form and
Guidelines for Completing the BPR

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Publication 238 (2021 Edition), Appendix IP 02-B
BPR Form and Guidelines for Completing the BPR

Instructions for Bridge Problem Reports (BPR)

The purpose of the Bridge Problem Report is to present a concise "news" report to executive staff and other critical responders on a bridge incident as it unfolds. It is not intended to be a final report on a problem, but a method to provide timely, key information to those who may be part of the response team, including:

- *Deputy Secretary for Highway Administration*
- *Chief Bridge Engineer*
- *Traffic Engineering and Permits Section*
- *Director, Bureau of Project Delivery*
- *Director, Bureau of Maintenance & Operations*
- *Federal Highway Administration (Bridge Section)*

The completed BPR form is sent to the Deputy Secretary for Highway Administration and other key staff as soon as possible. Location maps and available photos or sketches are attached to the BPR. BIS will maintain a database of BPRs for additional study.

To be effective, a BPR must be:

- Timely – The BPR should be completed on the day the report is received, no more than 24 hours later.

  If some information is not available immediately to meet the deadline, it is preferred to issue an initial BPR and amend it later as new information becomes available.

- Brief – Usually 1 page, 1 ½ page maximum (not including photos, etc.).
- Informative – The form for BPR tries to lead the District and BIS to answer the following questions in a uniform format:
  - What happened?
  - When did it happen?
  - What was Department's response and when?
  - What needs to be done?
  - How much will it cost?
  - Associated priority maintenance items?
  - Priority maintenance item(s) Plan of Action?

The District is responsible to report to BIS that a bridge problem has occurred or is occurring as soon as possible. This early notice allows BIS to initiate the BPR process and gather general data about a bridge while the District is continuing its response to the bridge problem itself. The District should complete as much of the BPR form as possible. The District is responsible for the raw information that will be distilled into the BPR and needs to be provided to BIS in a timely manner. Information by e-mail is preferred, but phone messages will suffice.

The BIS provides any technical assistance and administrative help (procurement of consultants, etc.) to the District and prepares the BPR report and cover memo to the Deputy Secretary. Copies are sent to appropriate parties, including the District Bridge Engineer (via email).

The BPRs are maintained in a database in BIS to facilitate follow-up reviews on a particular problem, to review trends in similar problems, to study the Department's serious bridge incidents, etc.
BPRs are internal documents and are not for general release, especially as they may contain incomplete or unverified information from an ongoing investigation. Information suitable for public release may be gleaned from them.

<u>BRIDGE PROBLEM REPORT</u>

BMS Number: *(5A01)

BPR Number: *[Assigned by BOMO]*

Report By:		**Taken By:**		**Date:**	
District:	*(5A04)	**Br Type:**	*[Use name instead of 6A26-6A29 coding]*	**ADT_ON:**	*(5C10)
County:	*[County Name]*	**Year Built:**	*(5A15)	**ADTT_ON:**	*(6C27)
Route:	*[Route # + local road name]*	**Suff Rating:**	*(4A13)	**Detour Length:**	*(5C15)
Over:	*(5A07)	**SD:**		**Posting Status:**	*[Current and previous status]*
Br Name:	*{Local name, if avail.]*	**SD-Reason:**		**Fed Aid Sys:**	*(6A07)
Location:	*(5A02)	**Structure Length:**	*(5B18)	**Func Class:**	*(5C22)
Owner:	*(5A21)	**Span Length:**	*[e.g., 1 at 45 or 80-100-80]*	**MPMS#:**	[Identify appropriate project]
NHS:	*[yes/no]* *(5C29)	**Bridge Width:**	*(5C27)	**Prog Status:**	*{Is it on 12YP, Betterment, DF?]*
FCM:	*[Yes/No]*	**#Lanes:**	*(5A19)	**Funding:**	*[e.g. FCB, Betterment]*
				Est Letting Date:	*(AP17)

**Indicates data normally available in BMS2*

<u>Problem Description</u>

BIS completes this section from information provided by the District. When reporting a bridge problem:

- *State the main effect (bridge closed, emergency repairs) and the main cause (e.g. Scour, extreme deterioration, collision)*
- *Provide additional details on the event (e.g., heavy rains, reported by Maintenance, found during inspection)*
- *Outline details of structural problem (e.g., defect found on 4 of 12 locations, Fracture Critical Member, low capacity ratings)*
- *Outline steps District/owner has taken or will take in immediate future (e.g., repairs start in 2days, traffic to be restricted for __)*
- *Note if there were injuries or fatalities, collateral damage, if citation or police report, etc.*
- *Sketches and photos can enhance the understanding of a problem significantly. Digital documents via email are best, as they can be easily reprinted. FAX is acceptable.*
- *Maintenance priority and date of Plan of Action if applicable.*

<u>Follow-Up</u>

BIS completes this section from information provided by the District. Items for follow-up may include:

- *Immediate repairs, closing, load posting, detour signing, etc…*
- *Materials testing, analysis, continued monitoring, underwater or in-depth inspection, etc…*
- *Development of repair scheme, design drawings, etc…*
- *Cost estimates, request for emergency funding, coordination with locals, etc…*

<u>Previous Repairs Recommended</u>

Maintenance previously recommended in BMS2 and the Priority level for work items related to this BPR.

<u>Estimated Cost for Repairs</u>

BIS completes this section from information provided by the District. Provide costs of practical options. If a detailed cost estimate is not available, provide "ballpark" number or a range of costs.

BRIDGE PROBLEM REPORT

BMS Number:

BPR Number:

This structure safety inspection document is confidential pursuant to 65 P.S. §66.1 et seq., 75 Pa. C.S. §3754 and 23 U.S.C. §409 and may not be disclosed or used in litigation without written permission from PennDOT.

Report By:	**Taken By:**	**Date:**
District:	**Br Type:**	**ADT_ON:**
County:	**Year Built:**	**ADTT_ON:**
Route:	**Suff Rating:**	**Detour Length:**
Over:	**SD:**	**Posting Status:**
Br Name:	**SD-Reason:**	**Fed Aid Sys:**
Location:	**Structure Length:**	**Func Class:**
Owner:	**Span Length:**	**MPMS#:**
NHS:	**Bridge Width:**	**Prog Status:**
FCM:	**#Lanes:**	**Funding:**
		Est Letting Date:

Problem Description

Follow-Up

Previous Repairs Recommended

Estimated Cost for Repairs

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APPENDIX IP 02-C

Emergency Bridge Restrictions and Special Hauling Permits Action Plan

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Publication 238 (2021 Edition), Appendix IP 02-C
Emergency Bridge Restrictions and Special Hauling Permits Action Plan

When a bridge is no longer able to carry its intended loads it is imperative, for public safety, to prevent further damage or collapse by controlling traffic on the bridge. The need to prevent overloads on a weakened bridge justifies a thorough and urgent response.

For such situations, the Department may impose emergency restrictions on the bridge that include closing, vehicle weight restrictions, lane closures, prohibition of permitted vehicles, and other traffic control deemed necessary. The emergency actions (determined by the District Bridge Engineer) depend upon the bridge conditions and, in large part, to the likelihood of overloads. Because Special Hauling Permits are issued in advance of the actual move, it is more difficult to prevent overloads by already permitted vehicles than traffic generally. Previously approved Permits can be grouped as follows: 97.42% = “single-trip” Permits; 1.91% = annual, “network” Permits (almost entirely international containerized cargo); 0.66% = seasonal/annual, “specified route” Permits; 0.01% = seasonal/annual, “blanket” Permits.

Department Permit and Bridge staffs have gained experience by addressing past emergency bridge restrictions. This Action Plan identifies up to nine steps that may be needed to improve response time and communication to motor carriers operating under various Permits when there is a future emergency bridge restriction, particularly when the affected bridge is carrying an Interstate highway or major Traffic Route.

It is anticipated that all nine steps will need to be pursued in response to an emergency bridge restriction when the bridge is carrying an Interstate highway or major Traffic Route.

	ACTION	*RESPONSIBLE PERSON*	*EXPECTED RESULTS*	*PROS*	*CONS*
1	Establish need for emergency bridge restriction.	District Bridge Engr.	Makes recommendation for: ▪ Closing ▪ Weight Limit ▪ Lane Closure ▪ Permit Restrictions ▪ Urgency	Maintains public safety.	None.
2	Establish need for Variable Message Signs (VMS) to notify drivers en route. VMSs should be considered: ▪ On Interstates and Traffic Routes. ▪ On other routes where ADTT > 200. ▪ Until more permanent solution is in place. ▪ As alternative to more stringent restriction to bridge (Dist. Bridge Engr.). ▪ For advance locations, & bridge site. ▪ Parking for larger permitted vehicles may be needed in advance of structure until detour is established and Supplements are issued. Standard Emergency Closure / Detour Signs with weight *stickers* prepared in advance (e.g., Emergency Bridge Restriction & No Vehicles Over *80,000* lbs. Beyond Next Exit) should be considered: ▪ On all State highways. ▪ Until restriction is lifted. ▪ In addition to VMSs.	<u>Ad hoc committee</u>: ▪ District Executive/ Administrator. ▪ ADE-Maintenance. ▪ Dist. Bridge Engr. ▪ Dist. Traffic Engr. ▪ Dist. Permit Mgr. ▪ Dist. CRC. ▪ County Mgr.	Provides notification -- in advance of the new emergency bridge restriction -- to all motor carriers in route to restricted bridge.	▪ Timely, cost effective action. ▪ Last chance to notify driver. ▪ Difficult for driver to ignore. ▪ 100% prompt notification to affected drivers. ▪ Reduces risk and costs of further damage to bridge (when signs are obeyed). ▪ Maintains public safety. ▪ Consistent with Permit Restriction.	▪ Some time lag until VMS can be assigned to site and made operational. ▪ Suitable parking for larger permitted vehicles may not be available. ▪ Drivers *may* not obey message signs.

	ACTION	*RESPONSIBLE PERSON*	*EXPECTED RESULTS*	*PROS*	*CONS*
3	Post emergency bridge restriction in APRAS database.	District Permit Office.	Assures that emergency bridge restriction will be included immediately as part of analysis of *new* route-specific permit applications.	▪ Quick, cost effective action. ▪ Automatically addresses new route-specific applications. ▪ Maintains public safety.	▪ Internal database update only. Does not address: ▪ Unused single-trip Permits issued during previous 14 days. ▪ Seasonal & Annual Permits (see # 7, 8, 9).
4	Post Administrative "flash" Message about the emergency bridge restriction and need for permittees to obtain route-correction Supplements for previously approved Permits that have not yet crossed restricted bridge.	District Permit Office.	Notifies PennDOT Permit and Bridge staffs of emergency bridge restriction within 10 minutes.	▪ Quick, cost effective action. ▪ Allows internal system users to manually address new applications.	Does not directly address: ▪ Unused single-trip Permits issued during previous 14 days. ▪ Seasonal & Annual Permits (see # 7, 8, 9).
5	Post WEB Administrative "flash" Message about the emergency bridge restriction and need for permittees to obtain route-correction Supplements for previously approved Permits that have not yet crossed restricted bridge.	Central Permit Office.	Notifies APRAS WEB users of emergency bridge restriction within 20 minutes of initial Administrative Message posting.	▪ Quick, cost effective action. ▪ Allows external system users to manually address new applications.	APRAS WEB users may not identify every previously approved Permit that has not yet crossed restricted bridge.
6	Send e-mail of Administration Message to APRAS WEB users, again stressing need for permittees to obtain route-correction Supplements for previously approved Permits that have not yet crossed restricted bridge.	Central Permit Office.	Promptly notifies APRAS WEB users with e-mail addresses of restriction.	Additional communication to some APRAS WEB users.	APRAS WEB users may not identify every previously approved Permit that has not yet crossed restricted bridge.

	ACTION	*RESPONSIBLE PERSON*	*EXPECTED RESULTS*	*PROS*	*CONS*
7	Temporarily deactivate Permit Load Types associated with affected "Network(s)", until first business day of following week.	Central Permit Office.	Assures that emergency bridge restriction will be included as part of analysis of *new* "Network" permit applications.	▪ Quick, cost effective action. ▪ Automatically addresses new affected "Network" applications. ▪ Maintains public safety.	Tardy "Network" Permit renewals will not be processed until after weekend "Network" re-analysis and all District Permit and Bridge Unit manual reviews of updated Network(s).
8	Run "Bridge Crossing" report, using the BMS2 query function. Determine risk from still active, previously approved Permits and make follow-up contacts to permittees.	Run Report: BDTD or Central Permit Office. Contact Permittees: Affected District Permit Office.	Identifies previously approved Permits that are still valid, including: ▪ Annual NON-Blanket Permits. ▪ Seasonal Permits. ▪ Single-trip Permits issued within past 14 days. Affected District's staff contacts Permittees about still active, previously approved Permits.	▪ Affected Permittees advised NOT to travel across restricted bridge (and to obtain route-correction Supplements). ▪ Eliminates some roadside waiting for Supplements.	▪ BMS2 query database updated on weekend refresh only. ▪ Labor-intensive. ▪ Blanket Permits not addressed (see # 9).
9	Run report to identify active Blanket Permits. Initiate mass mailing to Blanket Permittees to inform them of emergency restrictions.	Central Permit Office staff with access to the BMS2 query function can run "reports", including mailing labels.	Notifies Blanket Permittees (who travel non-specified routes).	Assures Blanket Permittees are notified.	▪ BMS2 query database updated on weekend refresh only. ▪ Labor-intensive.

APPENDIX IP 02-D

General Scope of Work –
Safety Inspection of Sign Structures

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Publication 238 (2021 Edition), Appendix IP 02-D
General Scope of Work – Safety Inspection of Sign Structures

I. GENERAL

A. Purpose

The purpose of this inspection program is to verify each sign structure's inventory data, to determine its physical condition and maintenance needs, and record the information in the Department's Bridge Management System 2 (BMS2). In addition, the scope shall include performing limited bolt replacements and/or tightening as needed and replacing bulbs on lighted signs attached to sign structures.

This document is to provide methodology and procedures for those inspections.

B. References

The requirements of the latest versions of the Department accepted AASHTO and FHWA manuals and the latest versions of Department Publications and Policy, including any updates, shall be followed in the performance of the Scope of Work. See the Department's Bridge Safety Inspection Manual, Publication 238, IP 1.3.2 and IP 1.3.3 for a list.

II. TYPES OF SIGN STRUCTURES

Sign structures are typically constructed of either galvanized steel or aluminum. There are also some painted and unpainted weathering steel structures.

A. The five (5) basic types of sign structures in Pennsylvania:

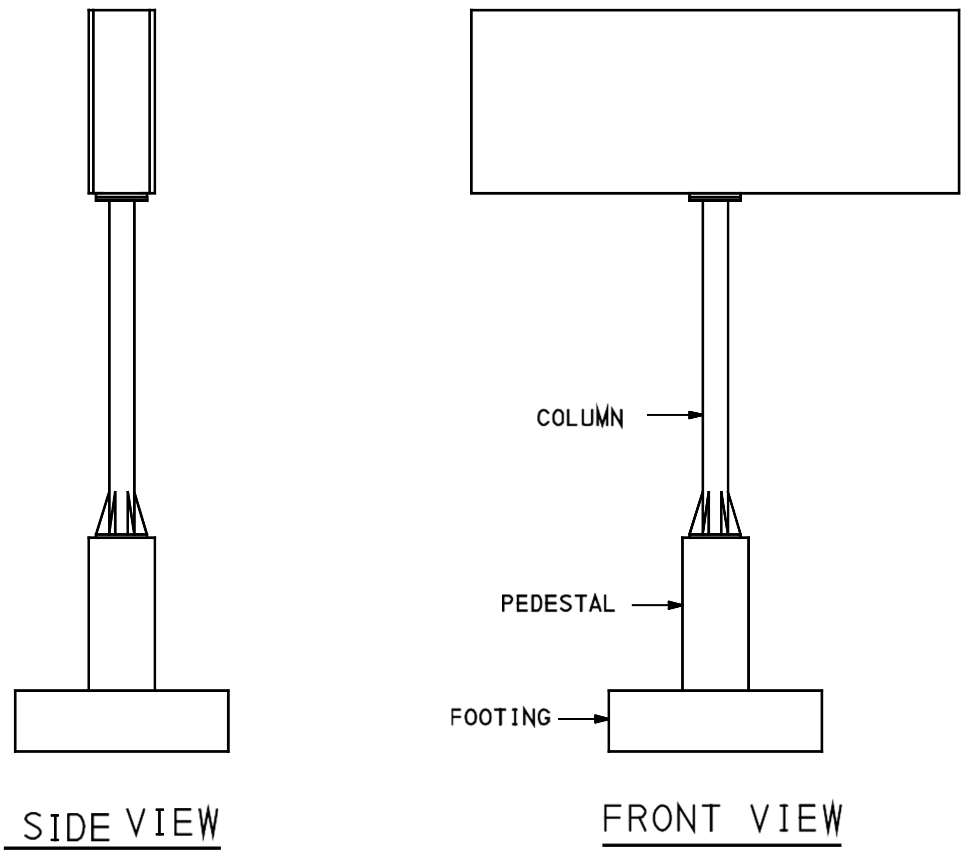
1. **Overhead** - consisting of one or more horizontal members supported at each end. Overhead structures may be multi-span. Subtypes include: planar trusses, 3 or 4 chord trusses, tubular, and rigid frame structures (See BD-642M through BD-645M or BC-742M through BC-745M for examples).
2. **Cantilever** - consisting of one or more horizontal members supported at only one end (See BD-641M or BC-741M for examples)
3. **Center Mount** - consisting of one or more horizontal members supported at the center, often used to support Variable Message Signs (VMS) (See BD-641M or BC- 741M for examples).
4. **Pole-Mounted** – Used exclusively for VMS (see next section), pole mounted sign structures typically have a mounting plate welded to the top of the single column support. The structural framework of the VMS is mounted to a similar sized base plate that bolts directly to the pole mounting plate (See sketch below).
5. **Structure-Mounted** - a sign attachment permanently mounted to the fascia beam and/or face of parapet to be visible to traffic beneath the bridge. These signs are typically inspected during the bridge's NBIS inspections.

Sign Structures that are erected on bridge piers, parapets, brackets, etc., that are visible to traffic on the bridge are to be classified according to type (type 1 thru 4 above) and not as Structure-Mounted. They must be inventoried separately from bridges.

B. Variable Message Signs (VMS)

Variable Message Signs (also known as Dynamic Message Signs) consist of modern Light Emitting Diode (LED) display boards that can be remotely controlled to provide real-time traffic updates or convey other critical information to motorists as needed. VMS signs require a housing and often have their own "walk-in" structural cabinet to contain the various electronics needed to power the sign. Therefore, VMS are typically much larger and heavier than standard flat panel signs. Failure of a VMS support structure has a much greater potential for catastrophe than that of standard flat panel signs. For this reason, sign structures supporting VMS require special attention during inspections.

EXHIBIT A



POLE MOUNTED VMS SIGN STRUCTURE

III. TYPES OF SIGN STRUCTURE INSPECTION WORK

There are 5 inspection types, all of which include close visual and hands-on examination of the sign structures. A brief description of each of these is given below:

A. Initial Inventory
Insufficient or no data is available in BMS2. An inspection fulfilling the Department's sign structure safety inspection requirements has never been performed. This type of inspection provides for the collection of a sign structure's inventory data for entry into the Bridge Management System 2 (BMS2). All items included on BMS2 Coding Forms D- 491 must be completed. This work includes an In-depth inspection as described below.

B. In-depth
A close visual and hands-on examination of each component, member, fastener, and weld on the structure, and/or non-destructive field tests, and/or material tests are performed to fully ascertain the existence of or the extent of any deficiency. Lane closures are anticipated to permit access to all portions of structure. Existing inventory data is to be updated

C. In-depth (Alternate Lanes Closed)
A close visual and hands-on examination of column bases, end supports, and selected portions of horizontal members. Areas of horizontal members to have close hands-on inspection, and/or non-destructive field tests, and/or material tests performed to fully ascertain the existence of or the extent of any deficiency, are selected to provide overall safety while minimizing traffic disruption. Existing inventory data is to be updated.

D. Routine
A close visual and hands-on examination of all portions of the sign structure. Lane closures are anticipated to permit access to all portions of structure. Ladders can be used to access end supports away from traffic. Existing inventory data is to be updated.

E. Special Inspections
An inspection to provide in-depth assessment of special conditions when significant structural deficiencies, severe section loss, collision damage, or corrosion have been noted. These inspections will be performed as directed by the District Bridge Engineer.

Inspection types B, C, D and E are done subsequent to the initial inventory inspection and involve only a cursory review of the inventory data to verify correctness. These four different levels of effort can be used to evaluate the sign structure based on its condition and inspection history.

IV. INSPECTION INTERVALS

The inspection interval and level of inspection intensity for sign structures are influenced by structure material, structure type, condition and age. Table IP 2.11.3-1 in Publication 238 establishes the inspection intervals for the various types of sign structures. Structure-Mounted sign structures are to be inspected along with the other bridge components as part of the biennial NBIS safety inspections. Table IP 2.11.3-2 in Publication 238 lists the typical cycles for conducting safety inspections for different sign structure types and varying conditions.

V. INSPECTION REQUIREMENTS

A. Inspection Procedure
Inspect in accordance with Section VII of this SOW entitled Field Inspection Procedures. Clearly record all inspection field notes on D-491 Forms and on Inspection *i*Forms. Prepare sketches, if required. Obtain digital photographic documentation. Refer to Bridge Management System Coding Manual, (Publication 100A) and its updates for completing appropriate portions of forms. Precisely identify all areas of section loss and comment on their impact on the support's structural strength. Perform dye penetrant testing if needed. Indicate maintenance items needed and their priorities on D491 Forms and *i*Forms. Complete, update, or amend the required BMS2 inventory and inspection items on the printout of the BMS2 records. *Districts, when practical, are to select groups of sign structures along a given corridor when preparing Work Orders.*

B. Fastener Installation
Replace missing or damaged fasteners as required. Select replacement fasteners with closest diameter and size match from hardware provided by the Department. Note that tightening of existing bolts is considered incidental.

C. Light Bulb Replacement
Replace all bulbs on lighted signs attached to overhead sign structures (including cantilever sign structures) during Routine Inspections. Light bulbs are to be provided by the Department. The need for routine bulb replacement to be included in Routine sign structure inspections is to be determined by each individual District.

VI. PRE-INSPECTION DATA COLLECTION AND INVENTORY INFORMATION

A. Initial Inspection and General Structure History

Prior to the start of field inspections, obtain the following information for each structure:

1. Existing plans or sketches. For VMS's obtain plans or sketches for both the sign housing and the supporting structure.
   a. Design drawings or applicable Standard with dimensions added (BMS2 Item VN05), including any retrofits since the initial construction (i.e. replacement of standard flat panel sign with a VMS).
   b. Shop drawings, including drawings for retrofits (BMS2 Item VN06).
   c. Supplemental sketches with photographs. When shop drawings are not available, provide detailed sketches with dimensions.
2. Map with location of structure - include both a Type 10 County Map and an Interchange Map.
3. Date structure was built (BMS2 Item 5A15). Leave blank if no drawing is available. As a last resort, District Inspection Unit will provide this date using engineering judgment based on when the section of surrounding highway was constructed.
4. The following items are usually available on roadway plans and/or shop drawings, and should be recorded in narrative fields (BMS2 IS Screen):
   a. Material - type of metal (also alloy if known)
   b. Name of fabricator and plant location
   c. Designer/Consultant of Record - provide this narrative on the IS Screen
5. Any records of damage and/or repairs to structure (provide sketches and/or photographs).

B. Subsequent Inspections

1. Obtain a copy of all previous inspection reports for all sign structures being re-inspected.
2. Inspector to mark any necessary inventory changes on the D-491 forms and provide to the Department for revision.

C. Referencing Nomenclature

Use the following referencing nomenclature:

1. Near side / far side – the NEAR SIDE of the sign structure is as indicated in Publication 100A.
2. Truss Referencing – The four (4) chord truss system will be referenced as (LF) lower front; (UF) upper front; (LB) lower back; (UB) upper back. The Panel Points will be numbered from left to right, while looking at the Near Side of the Frame. The three (3) chord truss system should be referenced as noted above, except that the back single chord is referred to as the mid-chord. Example: The interior diagonal from upper chord (U6) to mid-chord (M7) should be labeled U6-M7.

D. Inventory Information

All inventory items *i*Forms VS form are to be completed for initial inspections. This information is to be verified and corrected during all subsequent inspections.

E. Clearance Sketch

Provide a sketch of the sign structure and roadway features showing all clearances. Roadway centerline, lane widths, shoulders, and guiderails are to be shown. Vertical clearances over roadway pavement and shoulder breaks are to be indicated. This data is to be field verified at each inspection.

F. APRAS Form SC

RMS Route (SC02), Non Restricted Vertical Clearance (SC03) and Minimum Under- clearances for Routes On and Under the Span (SC09 and SC10) items are to be completed on SC Screen of BMS2.

VII. FIELD INSPECTION PROCEDURES

A. General Instructions

These procedures provide instructions for some aspects of cantilever and overhead sign structure inspection. Many of the techniques from bridge inspection are also applicable here. Use appropriate portions of these Guidelines and bridge inspection procedures to inspect Structure-Mounted signs.

1. Completely inspect all elements, cleaning members as needed to assess condition. Clearly record all inspection field notes in *i*Forms. Provide sufficient comments and descriptions to justify condition and appraisal ratings. (See Publication 100A, Inspection-Signs/Lights) Identify and record in *i*Forms locations where visual as opposed to hands on inspections were performed, if any.
2. Record and/or photograph any manufactured markings on the structure.
3. List and prioritize needed Maintenance Items on *i*Forms form IM. Additional bridge items from 3A screen may be added as appropriate (See Publication 100A).
4. Report any public safety threatening deficiencies that are observed and provide emergency retrofit schemes, as directed, to any critical conditions uncovered.
5. Using a magnet, verify whether the metal is steel or aluminum. Check several locations. The same metal is not always used throughout the structure (i.e. steel towers supporting an aluminum truss, or a steel column supporting an aluminum VMS cabinet). Note any variations in material.
6. Inspect for dents, cracks, rust, and overall condition of galvanizing.
7. Visually inspect all welds for cracks, especially where galvanizing is peeling, cracked or shows signs of rust. Primary points of interest are column to base, cantilever arm to pole and splice connection plates welds. Pay particular attention to welds in aluminum structures, and at locations of intersecting welds, such as at corners of base plate welds and gusset plates.

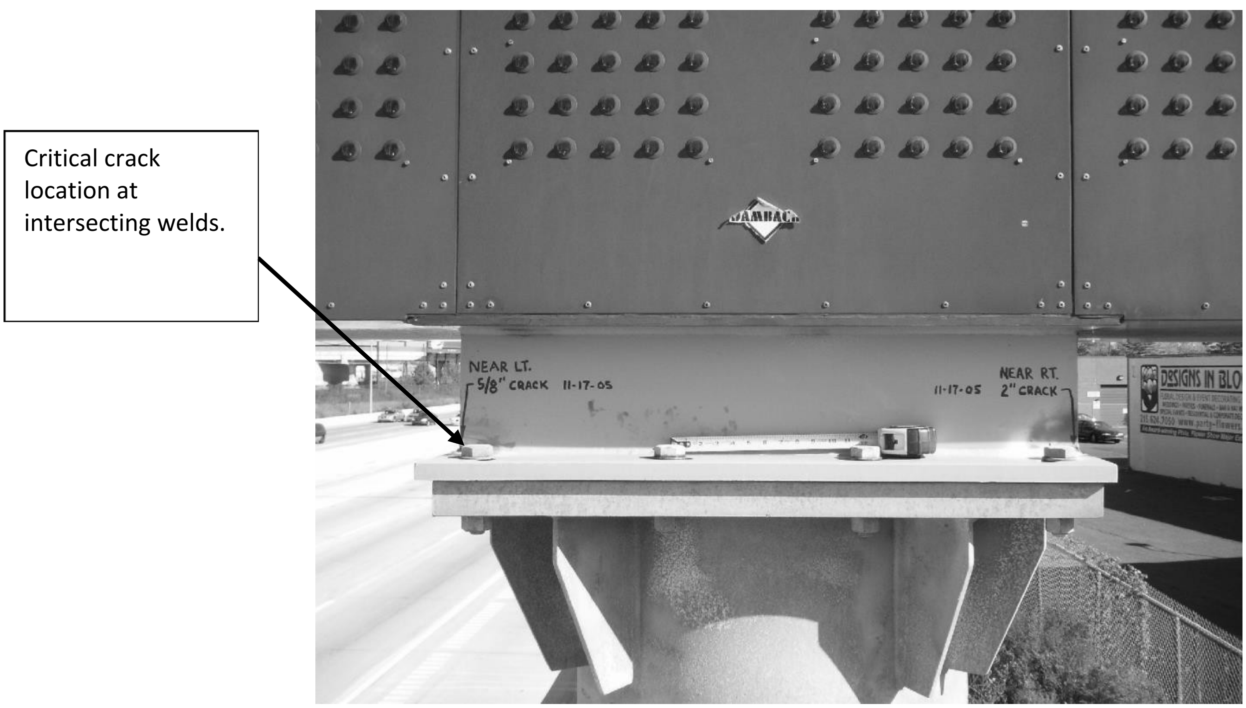


Figure 1. Critical Crack Location at Sign Base.

8. Dye-penetrant testing (ASTM E165-92) is to be used whenever cracking is suspected. Results of dye-penetrant tests at critical weld locations outlined above must be provided in all in-depth inspection reports. Other non- destructive testing methods, including ultrasonic (UT), may be used upon the approval of the District Bridge Engineer.
9. Repair portions of galvanizing damaged during testing using galvanizing paint.
10. For all sign structures approved by the District, replace all bulbs on each lighted sign during Routine Inspections.
11. Inspect all bolts and nuts for tightness, any indication of section loss and/or cracking, and rusting.
12. Record any bolts needing replacement and any missing bolts, nuts, or washers in the "Maintenance Items" section of BMS2. Select maintenance priority carefully as this can be a critical deficiency, depending upon location and redundancy. Show location of bolts tightened, replaced or requiring replacement on sketch.
13. Paint the nuts of any replaced or retightened bolts using the following color coding:
    - White - Replace Bolts
    - Yellow - Retighten Bolts
    - Red - Bolts that need to be replaced or those unfit for permanent re-tightening (see below)

NOTE: 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 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. If the bolt and nut are part of the primary support system for a VMS sign, they must be identified for replacement regardless of whether or not they pass the thread test outlined above.

For A490 bolts: Do not re-tighten. Replace bolt and nut.

To install/tighten bolts, use turn-of-nut method. Snug tighten all bolts to the full effort of a person using an ordinary spud wrench; then tighten bolts as indicated in the following Table (from Pub. 408, Section 1050 Table B):

Nut Rotation from the Snug-Tight Condition (1), (2) Geometry of Outer Faces of Bolted Parts

Bolt length measured from underside of head to end of bolt	Both faces normal to bolt axis	One face normal to bolt axis and other face sloped not more than 1:20 (20:1). Bevel washer not used.	Both faces sloped not more than 1:20 (20:1) from normal to bolt axis. Bevel washers not used.
Up to and including 4 diameters	1/3 turn	1/2 turn	2/3 turn
Over 4 diameters but not exceeding 8 diameters	1/2 turn	2/3 turn	5/6 turn
Over 8 diameters but not exceeding 12 diameters(3)	2/3 turn	5/6 turn	1 turn

(1) Nut rotation is relative to bolt, regardless of the element (nut or bolt) being turned. For bolts installed by 1/2 turn and less, the tolerance should be ±30 degrees; for bolts installed by 2/3 turn and more, the tolerance should be plus or minus 45 degrees.

(2) Applicable only to connections in which all material within grip of the bolt is steel.

(3) No research work has been performed by the Research Council on Structural Connections to establish the turn-of-nut procedure if bolt lengths exceed 12 diameters. Therefore, the required rotation must be determined by actual tests, in a suitable tension device, simulating the actual conditions.

14. In accordance with Pub. 15M (DM-4), Section 3.6.3 and Pub. 100A, IS15 (Sign Asset Tags), record the existence and condition of asset tags.

B. Column Base, Foundation, etc.

Include an assessment of the concrete foundation conditions, concrete column/pedestal, anchor bolts, grout (if used between foundation and base plate), tubing, and all welding of support members to base plates.

1. Inspect all footings visually or by feel (e.g. probing) for conditions, integrity, safe load capacity, etc.
2. Check concrete foundation for soil erosion, spalling and/or cracks; noting any vegetation growth through cracks. Also check and note condition of grout, if used.
3. Note any settlement or movement of foundation.
4. Note any soil or material build up around foundation, base plate, and/or column and add a maintenance item for cleaning/removal of material.
5. Conduct soundness test of the concrete foundation by listening to the sound made when lightly tapped with a hammer. Any areas around the outside of the foundation that exhibit a hollow ringing sound are to be noted for further evaluation and/or testing.
6. Inspect the base plate, gussets and tubing - outside (and inside where possible) for rust, ponded water, weld cracks, and condition of galvanizing.
7. 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 bolts. 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. Tighten any loose nuts with spanner wrench and 4-foot pipe extension in accordance with the table on page 6 and record where the loose or missing nuts are needed. If the full turn of the nut tightening is not obtained as indicated above, provide a recommendation for priority maintenance item. Loose or missing anchor bolts or nuts on cantilevers should be considered a critical deficiency. For other sign structures with 2 or more supports the anchor bolts are priority 2. Establish priority for maintenance items accordingly.
8. Use ultrasonic inspection if deemed necessary by Bridge Engineer to verify anchor bolt length and/or to determine if defects are present.

C. Columns

This includes single columns, or multi-column towers for overheads, as well as that portion of rigid frame overhead structures outside the first splice in horizontal portion.

1. Inspect the strut to column connection(s) on cantilever and center-mount structures, and/or the truss connections to the column(s). This includes the connection plate(s) and all welds.
2. Inspect for straightness and plumbness of members.
3. Inspect tension portions of rigid frame "columns".
4. Inspect the bottom of "columns" just above the base plates ultrasonically for internal section loss using an ultrasonic thickness gage (D-meter); perform the same type of inspection at other areas where internal section loss is suspected.
5. Inspect bent sections of monopipe sign structures for cracking and rust which may be a result of crimping during fabrication.

D. Horizontal Members

This includes struts, planar/3D trusses, portions of rigid frames and tubular overhead structures between exterior splices, and the framework for structure-mounted signs.

1. Inspect the splice plate and bolts/nuts for rusting, cracks, and condition of galvanizing.
2. Inspect all welded connections of the horizontal, vertical and diagonal members for cracking, weld condition and galvanizing.
3. Special attention must be given to the connections in the vicinity of the attachment to the column or at sign attachments.
4. Inspect for sagging or excessive deflection.

E. Sign

This includes the structural condition of the signboard and its accessories/attachments, not the legibility or visibility of the message.

1. Inspect all elements connecting the sign to the supporting structure, and all connections in the sign support framework.
2. Obtain access to the interior of "walk-in" cabinet type VMS signs, or open sign panels for front access VMS signs to inspect any structural framework of the sign that can be accessed by non-destructive means.
3. Report missing and/or broken nuts, or bolts in the maintenance items to the District Bridge Inspection Supervisor.
4. Perform dye-penetrant testing on aluminum or stainless steel sign attachment clip nuts. For Structure-Mounted signs, test 5% of the bolts at or near top of parapet, if any cracking is observed test an additional 10%. For Overheads and Cantilevers, perform dye-penetrant testing if cracked or missing nuts are observed following the above percentages.
5. Tighten loose or replace missing or damaged 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 unlubricated.
6. Inspect sign face extrusions for damage.
7. Visually inspect the aluminum sheeting for map cracking or other damage.
8. Record sign legend and approximate area of sign (use of collapsible survey rod would aid in obtaining many of the dimensions).

F. Powder Actuated Fasteners

If this fastener type is encountered for structure mounted signs during the course of a normal bridge inspection, the sign must receive a close visual and hands-on inspection for corrosion of the girder or fasteners. (Note: This will probably require a lane closure). Inspectors must peen the nuts of the fasteners and apply a light prying force to the sign to determine if the connections are still intact. Note in the narrative that this fastener type is present on the girders.

Any sign attachment of this type showing significant corrosion or loss of fasteners must be removed immediately (BMS2 Maintenance Priority Code "0"). Sign installations using these fasteners which are found to be still intact, should be given a BMS Maintenance Priority Code of 3, "Add to scheduled work." for replacement of the fasteners.

G. Lights and Electrical Components

This is the inspection of structural components of the lights and electrical components. It is not an electrical inspection.

For worker safety, lighted sign structures may have to be de-energized during inspection of sign structure. Districts are to provide needed keys to the inspectors.

The following items must also be completed:

1. Inspect light support for tightness where attached to the truss chords. Also check structural

condition of luminaires.

2. Locate and remove handhole covers in columns to check for drainage,corrosion, and vegetation growth inside the tubing. Remove any rodent nests or vegetation present. Make sure wire screens are installed around base plates. Visually inspect the condition of electrical components in the handhole.
3. Visually inspect electrical control box for damage.
4. For all sign structures approved by the District, replace all bulbs on each lighted sign during Routine Inspections.

H. Access Conditions (BMS2 Item IS05)

Means of access for inspection and maintenance of sign structure must be evaluated. The adequacy of both the access main members and their attachments must be considered in determining this condition rating.

I. Condition Ratings for Structural Components

Refer to the BMS Coding Manual's Condition Rating Codes for Sign Structure screen.

J. Equipment List

Most of the equipment needed for sign inspection is contained in the BIRM's list of typical bridge inspection equipment. The following equipment is needed or especially useful for the sign structure inspections.

1. Dye-penetrant testing kit
2. 24-ounce ball-peen hammer
3. Cans of cold galvanizing or zinc rich paint
4. Binoculars (10 X 50)
5. Magnet
6. Dial-indicating Torque Wrench (0-300 in.-lb. range.)
7. Pipe wrench
8. Spanner wrench and 4-foot pipe extension 9. Wrenches (1/2" to 1- 3/4")
9. Socket wrench and deep sockets (1/2" to 1- 3/4")
10. Standard size nuts, washers, bolts, and clips to replace missing components (provided by the Department)
11. Light bulbs (provided by the Department)
12. Ultrasonic thickness gauge (D-meter)

The consultant must arrange for all field equipment, inspection cranes, platform lift trucks, ladders, etc. Access for inspection of portions of the sign structures that are affected by railroad electrification must be arranged by the Consultant with the railroad company when necessary.

VIII. STRUCTURAL ANALYSIS

If significant section loss or damage from vehicular impact is found, a structural analysis of the sign structure must be performed. This analysis should be made using computer program(s) and/or hand calculations as needed. The District Bridge Engineer is to approve the need for and methodology of structural analysis. Use the following steps:

A. Acquire authorization from the District Bridge Engineer prior to performing a structural analysis.

B. Perform or update the structural analysis using a method acceptable to AASHTO and the Department.

C. Use conventional methods of analysis unless more complex and refined methods are specified or warranted and specifically authorized by the Department.

D. Ensure that all computations are in accordance with current Department and AASHTO Specifications. Update existing computations accordingly. When computer analysis is used, provide program input and output, calculations to prepare input, documentation of all assumptions, and any other post-processing calculations. Index computations so key data is readily available.

E. Use the Department's latest version of the SIGN software for analysis, if applicable.

If the structure to be analyzed is supporting a VMS sign, calculate wind forces in accordance with AASHTO Appendix C using a drag coefficient, C_d, equal to 1.7 per note 7 of AASHTO Table C-2. Also, in addition to the front or back face, the sides of the VMS are susceptible to ice loading, and the depth adds to the exposed area for calculating fatigue forces due to truck-induced gusting (AASHTO Chapter 11).

IX. DRAWINGS

A. Update existing drawings or sketches whenever possible, rather than preparing new drawings. Use the Department's design drawing revision procedure to note changes since original drawing preparation.

B. If no plans are available, prepare sufficient drawings to document the makeup of the structure. Include data and views as follows:
1. General plan and elevation.
2. Cross sections.
3. Framing plan.
4. Sketches of structural members (including dimensions).
5. Results of field inspection analysis, and historical data, when appropriate.
6. Structural details, including all fracture critical members unless adequately documented by photographs.
7. Locations of all fastener replacements and anchor bolt tightening.

C. Sketches done in an 8½" x 11" format are acceptable provided clarity of details and text can be maintained after being scanned into an Adobe "PDF" electronic format.

X. PHOTOGRAPHS

A. Provide new photographs to supplement field inspection notes and drawings and to document conditions. Include views of overall sign structure plus its side elevation, any defects, structural details, and bolt replacement locations. Photographs shall be sufficiently clear, properly identified, dated, and indexed and of a resolution and quality acceptable to the District.

B. All photographs to be stored as 1600x800 high resolution JPEG images.

XI. INSPECTION REPORT

A. Prepare a report to document the inspection, the sign structure, its condition, and recommendations. The report must be 8½" x 11" in size. PDF files are to be submitted via email.

B. General outline of the report is as follows:
1. Title page (Structure ID number, location, inspection dates, inspector names, prepared for and by, and Pennsylvania P.E. seal, signature and date.
2. Table of contents.

3. Location map(s). Map(s) must be of sufficient detail to locate sign structure.
4. General description and sketches and/or photographs of the overall sign structure.
5. Field inspection findings (completed *i*Forms Inspection Forms, plus new photographs and supplemental narrative to document findings).

   Include the following in the report narrative:
   - General description of the structure condition.
   - Summary of inspection findings and comparison with those of previous inspection, if available.
   - Structural adequacy and safety of the structure.
   - Discuss relevant historical data, if any.
6. References, list plans, previous reports, etc. used in the preparation of the report.
7. Recommendations. As a minimum, address the following:
   - Note legibility and condition of signs.
   - A prioritized time scheduled listing of immediate and long-term improvement needs for:
     - Maintenance — Complete *i*Forms form M
     - Rehabilitation — Complete *i*Forms form M or D-491M
     - Replacement — Complete *i*Forms form M or D-491M
8. Recommendations in report should be in "plain Englist" and be consistent with the costs indicated on the above forms.
9. Appendices:
   - Inventory Data: Marked-up copy of BMS2 file printout or completed copy of coding Forms D-491.
   - Inspection Data: Completed *i*Forms Inspection Forms.
   - Structural analysis, if available.
10. Identify the locations of all bolt replacements and anchor bolt tightening in accordance with the numbering system outlined in the guidelines. Reference bolt replacements in sketch or by photograph and indicate size.
11. Identify the locations of all light bulb replacements performed during the sign structure inspection. Reference location in sketch or by photograph.

XII. EMERGENCY REPORTING

The consultant shall notify the District Bridge Engineer immediately by phone whenever a potentially perilous or hazardous condition is observed. Provide written notification within 24 hours. Examples of such situations include:

1. Distress in primary members to the point where there is doubt that the members can safely carry the loads for which they are subjected, and partial or complete failure of the structure is likely.
2. Foundation movement or distress which is so excessive that there is a clear possibility that it may not be capable of supporting the structure and partial or complete failure is a possibility.
3. Any situation where the structural integrity of the structure or a portion of it is such that its safety is in question must be reported.

XIII. MATERIAL SAMPLING AND TESTING

Structural materials evaluation, non-destructive testing (except dye penetrant tests) and structure instrumentation are not a routine part of sign structure inspection. They may be required by the Department to eliminate unacceptable engineering uncertainties or to more accurately access the structure's safety. The owner may elect to use them at any time.

Justify the use and obtain District Bridge Engineer authorization before initiating any materials sampling and testing and/or instrumentation program.

XIV. EXISTING RECORDS AND DATA

The District will provide BMS2 access for sign structures to be inspected.

The District, if requested by the Consultant, will give the Consultant access to any available pertinent information for short term use and copying. This information could include existing structure drawings, structural analysis and design computations, inspection reports and other pertinent information. This data might be available only on microfilm.

XV. QUALIFICATIONS OF INSPECTORS

Personnel assigned to the Inspection Project by the Consultant shall meet the requirements set forth in the National Bridge Inspection Standards for all work levels.

Inspection personnel must hold a valid certification as "Bridge Safety Inspector" issued by the Department. See Publication 238, IP 2.1.3, for additional information.

XVI. TRAFFIC CONTROL

The Consultant shall provide traffic control during the inspection as needed to comply with the Department's Temporary Traffic Control Guidelines, Publication 213 and to insure the safety of inspectors and the traveling public at all times. Whenever possible, coordinate inspection effort with other work that is planned at the site to minimize disruption of traffic.

Any anticipated lane closures should be coordinated in advance since the times for inspection may be restricted by the District Bridge Inspection Supervisor or District Traffic Unit due to anticipated traffic conditions.

For traffic control details differing from Publication 213, submit a sketch to the District for approval. The District will identify these sites.

XVII. RELEASE OF INFORMATION

The safety inspection of sign structures is not for public record under PA Right to Know Law [65 P.S. §67.101 et seq. and PA Vehicle Code, Title 75 [75 Pa. C.S. §3754(6)].

Place the stamp appropriate to structure owner per section IP 1.8.3 on the front cover of the inspection report. Do not release or distribute inspection information without the written permission of the District Bridge Engineer for State structures or the structure owner.

When portions of a report are approved for release, include the language provided in Publication 238, Figure IP 1.8.3-2, to each page of the structure inspection report that is released.

XVIII. SUBMISSIONS

A. Work Schedule and Status

Submit a horizontal bar graph type work schedule within two weeks of notice to proceed for each work order. Also provide Open Plan data file via email unless otherwise directed. Submit monthly overall progress for each work order updates via email.

The Consultant shall be prepared to start work immediately upon execution of the work order. All work shall be completed expeditiously and not later than the date specified on the work order. Prior to beginning work, the consultant shall inform the District Bridge Engineer of the schedule of inspection of their sign structures(s) and names of the inspectors.

B. Field Inspection Data
Submit inspection data to BMS2 for Department's approval. In addition, submit a BMS2 printout marked with revisions and/or Form D-491 and/or *i*Forms within ten (10) days of the completion of each field inspection.

C. Draft Inspection Reports
Submit the draft report within four (4) weeks of the completion of each field inspection for review. Make Inspection Report submissions to the Department at frequent intervals to facilitate timely reviews. Submit an additional sample draft report for the first five (5) submissions to the Department.

D. Final Inspection Reports
Submit an electronic file in pdf format of each final report within three weeks of receiving the review comments of draft report. Each report shall be signed by a Pennsylvania Licensed Professional Engineer knowledgeable of the report content. All submissions must be finalized before the contract expiration date.

XIX. PRICE PROPOSAL

The method of payment will be based on a cost per unit of work for the categories shown in EXHIBIT B.

The District will identify sign structures to be inspected. The District and Consultant shall select the appropriate category applicable to each unit prior to preparation of the work order.

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EXHIBIT B – PRICE FOR UNIT CATEGORY

Inspection Type		A	B	C	D
Name of Work CATEGORY	Work Category	Initial Inventory	In-depth*	In-depth* (alt. Lanes Closed)	Routine*
Cantilever (1 lane)	C1				
Cantilever (2 Lanes)	C2				
Overhead (≤ 2 lanes)	O2				
Overhead (3 lanes)	O3				
Overhead (4 lanes)	O4				
Overhead (5 lanes)	O5				
Overhead (6 lanes)	O6				
Overhead (7 lanes)	O7				
Overhead (8 lanes)	O8				
Overhead (9 lanes)	O9				
Overhead (≥ 10 lanes)	O10				
Add'l Column/Tower	T1				
Bolt+ Replacement During Inspection(each)	BR1				
Light Bulb++ Replacement During Inspection (per lighted sign attached to sign structure)	LBR1				
Supplemental Inspection	S2				

* Inventory data to be provided by District for verification.
\+ Anchor bolt nuts, aluminum sign clips and Hi-lock nuts.
++ Light bulbs.

The Work Category for individual overhead sign structures is to be adjusted for sign structures over wide medians. The adjustment is applied to the number of lanes as follows:

Work Category Adjustment for Overhead Structures with Wide Medians	
Median Width, W (BMS2 Item VS30) U.S. Customary Units (ft.)	Additional No. of Lanes
W ≤ 24	0
24 < W ≤48	1
48 < W	2

Examples:

Sign Structure	Type	Actual Lanes	Median Width	Adjusted Lanes	Work Category
Overhead	D	2	10	2	02
Overhead	D	4	30	5	05

For Work Categories 02 through 010, the Scope of Work includes inspection of 2 towers. For sign structures with more than 2 towers, the additional towers will be paid under Work Category T1.

For performing special investigations beyond the scope of work for inspection types A to D, supplemental units of work, consisting of 2 labor hours each, may be assigned by the District.

Bolt replacement (including anchor bolt nuts) will be paid on a cost per unit of work basis for each missing or broken bolt replaced, using bolts, nuts and washers provided by the Department. Tightening of bolts remaining in place is considered incidental to inspection.

Light bulb replacement will be paid on a cost per unit work basis for each lighted sign attached to the sign structure, using bulbs provided by the Department.

Traffic control, fasteners, rigging, testing (except dye penetrant testing), sampling and railroad involvement (if required) will be paid as a direct cost for nonprofessional services. The consultant will be paid the actual cost based on certified invoices. Should anticipated cost exceed three thousand dollars ($3,000) per work order, the consultant must solicit bids.

XX. GENERAL INFORMATION

Project Manager for Department: The District in which the sign structures are located.

Agreement Administrator: Bureau of Maintenance and Operations, Asset Management Division.

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APPENDIX IP 02-E

Standard Practices Manual for
Measuring & Documenting Scour
During Bridge Safety Inspections

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INTRODUCTION

This is a Standard Practices Manual (SPM) for documenting the findings of scour-related features during the inspection of bridges over water. Information provided in the SPM is to:

- Address AASHTO's Manual for Bridge Evaluation (MBE) requirements found in Chapter 2:
  - Provide bridge waterway cross sections, channel cross sections or sketches (as needed), soundings and site map.
  - Provide adequate information on the stability of the waterway to assess the risk to the structure.
  - Determine and document a frequency for obtaining and updating measurements.
  - Perform a historical comparison to determine the extent of changes over time.
- Determine the extent of stream stability or instability to accurately code streambed scour related items such as 4A08 Scour Critical Bridge Indicator (SCBI), IN03 Scour Rating, IN15 Streambed Material, and 1A05 Channel and Channel Protection.

This SPM is intended to supplement the FHWA NHI Bridge Inspector's Reference Manual (BIRM), specifically Chapter 13 – Inspection and Evaluation of Waterways, and to form uniform practices to inspect bridges for scour in Pennsylvania. Additional resources are the Procedures for Scour Assessment at Bridges in Pennsylvania and the SCBI/SAR Calculator Manual as indicated in Section 2.6; hyperlinks are also provided on the login screen of BMS2. Some practices may not apply to every bridge but are shown here to provide uniformity and completeness of documentation in bridge inspection reports.

As part of inspection planning, inspection managers should review the files and the latest reports of upcoming bridge inspections and note any missing file components (i.e., USGS Data, cross sections, soundings, site map) or items that do not meet current standards. Such deficiencies should be corrected in the next Routine, Underwater or scour related Other Special (Interim) Inspection.

Section I focuses on the site map. The remaining Sections, II through IV, describe other important documentation of the waterway-bridge interaction that can assist in determining the cause of scour so that an effective scour countermeasure can be implemented when needed.

All documents should include the originating inspection date and the inspection dates of any subsequent updates. Additional information is presented in the Department's Bridge Scour Evaluation Training Course.

I. SITE MAP

DESCRIPTION – Site maps are used to illustrate stream and site changes and identify the risk to a bridge from scour, lateral migration, channel erosion, and other causes. Site maps should also identify countermeasures that have been constructed to preserve the integrity of the structure. A sample site map is shown in Example 1. The site maps can be a hand sketch.

WHEN TO USE – Required for all NBIS length and state-owned >8' bridges and culverts over water.
- Complete during Initial (First Time) Inspections or next Routine Inspection.
- Update at Routine Inspections if changes occur and indicate when no change is observed.
- Update during Other Special (Interim) Inspection when required by Table IP 2.3.2.4-1 or as necessary for a Post-Flood Damage Inspection.

PRACTICE (See Example 1):

1. **Update site map to capture trends and history.**
   - Use Observed Scour Assessment (OSA) (by USGS) information when possible as a baseline.
   - Use consistent abbreviations, such as OSA abbreviations.
   - Document date of changes to map.
   - Reproduce the sketch when the map becomes cluttered. Retain the earlier version of the maps in BMS2.

2. **Show position of all substructure units and channel alignment.**

3. **Provide orientation details: North arrow, direction of segments ahead, direction of stream flow**

4. **Show location and quantity of:**
   - Scour
   - Substructure undermining
   - Debris and vegetation
   - Measures/Countermeasures
   - Aggradation, sandbars, etc.
   - Non-designed placed/dumped rock
   - Channel erosion, sloughing, cut banks, etc.
   - Meanders, lateral migration
   - Low/normal water channel location
   - Vegetation impeding water flow (e.g., brush, trees)

5. **Locate and quantify undermining of substructures.**
   - Indicate location along face of substructure, depth of scour hole, and horizontal extent under footing (Provide a supplemental detail sketch for significant undermining, see Example 1).

6. **Measures/Countermeasures**
   - Indicate type; rip-rap (including size), underpinning, grout bags/mattress, streambed paving, etc.
   - Show installation date, if known.
   - Measures are designed to resist scour; countermeasures are designed or placed to correct a known scour issue.

7. **Show location of channel cross sections (as required by Section IV of ths manual) on Site Map and identify points in the field by marking large trees and/or other features likely to remain stationary for easy future reference.**

8. **Probe Depths**
   - Probe depths soundings along the substructure unit are required and locations shall be labeled on the stream sketch. Additional probe depth soundings in the channel can be provided based on site conditions to provide information on channel scour, establish an average stream depth, and to help determine if and underwater inspection is required.

II. STREAMBED PROBES AT SUBSTRUCTURE UNITS

DESCRIPTION – Determining streambed and bottom of scour hole elevations are important relative to the bottom of foundations, typically the substructure footings. The "critical dimension" is the amount of scour necessary to expose the bottom of footing. This scour can lead to undermining as shown in Example 1.

Once undermining occurs, the horizontal extent of undermining relative to the front face of footing shall be documented (see the site map in Example 1) since this will also be a factor in determining the stability of the substructure foundation. For bridges on deep foundations (e.g., piles, caissons, etc.), the exposure height of the deep foundation elements must also be documented to determine stability. Inspectors must document findings in detail to enable a complete assessment of the foundation stability.

WHEN TO USE – All NBIS length and state-owned >8' bridges and culverts over water are to have measurements that determine the streambed and the bottom of scour hole elevations, if present, in the bridge file located in Documents screen of BMS2. Required frequency of streambed and bottom of scour hole elevations updates are shown in Tables A & B. Inspectors are still required to perform probing during other Routine or Other Special (Interim) Inspections, they simply do not need to update the measurements unless significant changes are found.

Table A: Streambed Probes at Substructure Units
(Bridge Structures and Bottomless Culverts)

4A08 Scour Critical Bridge Indicator	Frequency in Months
9 or N	Not needed
5, 7 or 8	48 or 60 [1]
3 or 4	24
≤ 2	Update at each inspection until associated scour repairs are complete (Maximum of 6 months).
[1] Underwater diving inspections are required at a 60-month inspection cycle instead of a 48-month cycle. Probing's should coincide with the underwater inspection.	

Table B: Streambed Probes at Substructure Units
(Culverts with Integral Bottoms and Associated Wingwalls)

IN03 Observed Scour Rating	Frequency in Months
7, 8 or 9	48 or 60 [1]
4, 5 or 6	24
≤ 3	Update at each inspection until associated scour repairs are complete (Maximum of 6 months).
[1] Underwater diving inspections are required at a 60-month inspection cycle instead of a 48-month cycle. Probing should coincide with the underwater inspection.	

PRACTICE (See Example 1):

1. **Determine extent of scour by measuring vertical distance from reference point of known, or assumed, elevation to bottom of streambed to establish elevation of stream bottom. The point of reference should be above the 100-year flood elevation or known high-water elevation listed in BMS2 Field IL05.**
   - Establish physical reference point(s) on the structure that are easy to find and reach at all times for "repeatability". The preferred location, top of barrier, will allow for measurement during flood conditions.

- Top of Barrier
- Top of Abutment/Pier
- Bottom of Beam
- P-K nail in substructure element.
- Field measurements are made:
  - Distance from reference point to water surface (RP Dist)
  - Probe depth (PD) = water depth + soft infill, at various points
- Calculate streambed elevation via spreadsheet:
  - Streambed Elevation , SB Elev = Reference Point Elev – RP Dist –PD

2. **Determine Critical Dimension from bottom of scour hole to bottom of substructure footings in inspection documents.**
   - Determine bottom of footing elevation via bridge plans (if available), or relative elevation based on field measurements. Document source of elevation reference (e.g. design plans, as-built plans, or assumed) Be careful not to mix elevation references without reconciling them to each other.
   - Differentiate between the bottom of footing and underpinning repairs as well as between the footing and aprons placed in front of the footing.
   - Critical Dimension = SB Elev – BFE = Distance from probed streambed to the Bottom of footing elevation.
     - If the scour hole is below the Bottom of Footing Elevation, list the negative value as opposed to a value of 0.

3. **Document scour-related measurements to substantiate SCBI and Observed Scour Rating (OSA), as well as recommended maintenance activities and maintenance priorities.**
   - Scour and/or undermining
     - Note length of footing exposed. Calculate % of footing length exposed.
     - Note area of footing undermined. Calculate % of footing length and area undermined.
     - Note horizontal extent of scour from front face of footing, including notation to distinguish between the orginal footing and any apron constructed afterwards
     - If probing finds soft materials (e.g., in-fill and sediments), include measurements and description – see IN17 Observed Scour Depth and IN24 Inspection Notes.
   - Estimate/calculate % of individual span's waterway opening blocked
   - Estimate/calculate % of total hydraulic area blocked or % area blocked below the design flow elevation

4. **Compare new scour measurements with baseline and previous inspection results.**
   - Establish a set of the earliest available scour measurements as the baseline in tabular form for efficiency (See Example 1). The baseline measurements should be carried forward for all future inspections.
   - Utilize digital methods, as much as is practical, for accuracy and to easily update from one inspection to the next.
   - Review changes from previous inspections and from baseline and use successive inspections for monitoring waterway trends to help aleviate future problems.

5. **Use Probing to measure and document scour (or lack of scour) along face of substructure units.**
   - Probe along face of footing for each substructure unit in water.
     - Establish streambed and bottom of footing elevations using actual or assumed elevation reference points.
     - If water is too deep for probing or if the velocity of the water is too fast, an underwater diving inspection may be necessary.
   - Probe during Routine Inspections in accordance with Tables A & B on the previous page for all NBIS length and state-owned >8' bridges and culverts over water and during Other Special (Interim) Inspection when reduced interval is necessitated by scour.
   - Probe during each Post-Flood Damage Inspection.
   - The intensity and documentation should increase as scour approaches the bottom of footing.
     - When stream bottom adjacent to the substructure unit is above the top of footing, the probing measurements may be limited to intervals along the quarter points of a substructure element.

  - Provide the average elevation of streambed, as well as isolated minor scour hole(s).
  - When stream bottom is below the top of footing of a substructure unit, use additonal intervals at smaller spacings along substructure face as needed to locate deeper holes, using a table to record stream bottom elevation.
  - Note depth of "soft" streambed materials encountered when probing. The soft materials may be merely fine sediment infill of a deeper scour hole.
- Additional guidance on probing documentation:
  - If undermining of footing is present, determine depth and horizontal dimensions. Provide sketch of undermining with dimensions.
  - If underpinning repair has been installed, document horizontal dimensions, depth of repair and the date the repair was completed. Clearly state if scour measurements refer to orignal footing or to underpinning
  - See Example 1 for an example of probing substructure units for scour. Practices include:
    - Streambed elevations are determined relative to a known reference point.
    - Elevation of bottom of footing was determined and shown.
    - Streambed elevations under the bridge are recorded in tabular form using data entry into a spreadsheet.
    - Horizontal extent of undermining recorded in table and shown on sketch.
    - When wing walls experience scour, include probing measurement points at wings.

6. Store documents in BMS2 Documents for easy retrieval and reference.

- Use editable documents (like excel) for scour measurement for storing information in BMS2 Documents to facilitate scour documentation for subsequent inspections.

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III. BRIDGE WATERWAY CROSS SECTIONS

DESCRIPTION – Cross section along upstream side of bridge or culvert with elevations of stream bottom, bottom chord of superstructure, water surface, and bottom of footings determined from a known point of vertical reference. Include elevations for the upstream wing walls. If streambed movement is observed, provide additional information such as downstream elevations will be needed.

WHEN TO USE – All NBIS length and state-owned >8' bridges and bottomless culverts over water (See also Item 1, Basics of Measuring Scour), except those with Scour Critical Bridge Indicator = 9, are to have a baseline bridge waterway cross-section at the upstream face in the bridge file in BMS2's Documents link. Culverts with integral bottoms and their associated wingwalls are exempt from this practice.

Whenever waterway changes are apparent near the bridge then fully documenting stream changes with soundings, and cross sections are needed. Required frequency of Bridge Waterway Cross Section updates are shown in Table C:

Table C: Bridge Waterway Cross Sections
(Bridge Structures and Bottomless Culverts)

4A08 Scour Critical Bridge Indicator	Frequency in Months
9 or N	Not needed
5, 7 or 8	48 or 60 [1]
3 or 4	24
≤ 2	Update at each inspection until associated scour repairs are complete (Maximum of 6 months).
[1] Underwater diving inspections are required at a 60-month inspection cycle instead of a 48-month cycle. Probing's should coincide with the underwater inspection.	

PRACTICE (See Example 1):

1. **Waterway information is needed for all NBIS length bridges and state-owned structures greater than 8' over water with 4A08 SCBI < 9, including bottomless culverts.**
   - The size and height of some bridges can make this impractical and/or diminish the usefulness of the cross section for inspection purposes; an example of an exception to this rule includes large river crossings.
   - Only portions of the structure that are affected by the 100-year floor or fall within the high-water mark need to be recorded as part of the bridge waterway cross section.
   - Record this data during the Initial (First Time) Inspection.

2. **Make measurements to bottom of stream and reference to known point of elevation.**
   - Using water depth measurements alone is not acceptable.
   - The level of accuracy needed for these measurements (+/- 0.1') does not necessitate survey teams.
   - For arches, culverts, and other structures where elevation of bottom of superstructures varies along the span, show those measurements on sketch.
   - The reference points should be easy to access and clearly marked. The reference point shall be to top of barrier if feasible or another reference point if the top of barrier is not feasible. Other reference points include beam seats, bottom of beam, and a pk nail in a substructure element.

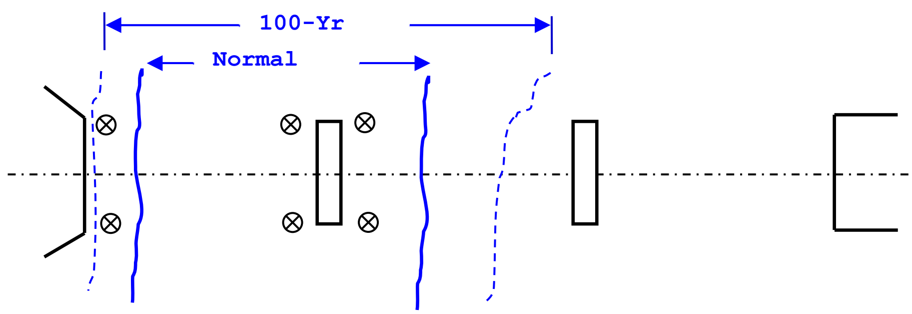
3. **Tailor intervals of measurement to bridge size. Suggestions are as follows:**
   - Small spans (< 30'): 3 Points, 1 at each substructure and 1 between to locate the thalweg.
   - Mid-size spans (30' to 200'): 5 to 9 points.
   - Large spans (>200'): Tenth points of the span length, not to exceed 50' between points

- Add locations if sandbars or aggradation encroaches on more than 10% of the waterway opening.

4. **The cross section at the fascia should include the following:**
   - Geometry of principal bridge openings up to the anticipated high-water elevation
   - Foundation units
   - Discernible scour holes
   - Discernible high-water marks at the bridge
   - Reference marks on the bridge
   - Sketch does NOT need to be a CADD drawing or drawn to scale
   - Provide bridge waterway cross-section for downstream fascia when one or more of the following conditions exist near the downstream opening of the bridge:
     - Significant sediment deposits
     - Advanced scour of more than 20% of footing length occurs
     - Significant stream migration has occurred

5. **Track scour progress over time:**
   - Use table to capture measurements from multiple inspections to allow for tracking. Minimizes re-drafting cross section.

6. **Use "Corner Scour Measurement" to assist in tracking scour and for monitoring scour during a flood event. These dimensions correspond to the measurements shown on the bridge cross section (See Example 1)**
   - Identify measurements for streambed elevations near each end of each substructure of every span to be checked during higher water. As indicated below, substructure units outside the 100-year flood limits or high-water mark do not need to be monitored.



LOCATION PLAN FOR CORNER MEASUREMENTS FROM TOP OF BARRIER

- Corner measurements should be taken beyond edge of footing (and underpinning if present) to avoid weights resting on top of the footing.
- Significant change indicates more detailed inspection and/or bridge closure is needed.
- Ensure monitoring measurements during high-water events are added to routine inspection measurements for complete records stored in one location.
- Corner measurements, by themselves, are not an acceptable substitute when full bridge waterway cross sections are called for but are used to supplement that information.

IV. CHANNEL CROSS SECTIONS

DESCRIPTION - Cross section located on upstream or downstream side of bridge showing elevations of stream bottom, high/low water channel, water surface, and vegetation determined from a known point of vertical reference. Channel cross sections are to be approximately parallel to the roadway crossing the structure. The cross sections will be approximated by lateral stream bed movement measurements and soundings for most cases. Actual stream cross sections would require the use of a survey crew; therefore, only provide actual cross sections if deemed necessary. In addition, aerial photograph may be used to monitor channel changes.

WHEN TO USE – For both NBIS length and state-owned >8' bridges, as well as bottomless culverts over water, (except those with SCBI = 9) stream cross-sections upstream and/or downstream of the bridge may be very useful in determining the bridge waterway's ability to convey the stream flow without jeopardizing the bridge foundation.

Whenever significant waterway changes are apparent (1A05 <=3), which threaten the bridge and/or approach roadway, then fully documenting stream changes with soundings, and channel cross sections are needed. If advanced channel condition change threatens the bridge, then channel cross sections are needed at the upstream and/or downstream sides of the bridge with an adequate number of sounding necessary to fully document stream changes. Inspectors are reminded that the coding of Item 1A05 – Channel Condition Rating is to be evaluated using both the general condition ratings as well as the channel and channel protection condition rating code descriptions. Required frequency of Channel Cross Section updates are shown in Table D:

Table D: Channel Cross Section Updates

1A05 Channel Condition	Frequency in Months
3[#]	12
≤ 2	Update at each inspection until associated scour repairs are complete (Maximum of 6 months).
#Note: 1A05 Condition Rating = 3 will initiate a reduced inspection frequency for the structure	

PRACTICE (See Example 1 for Approximated Channel Cross Section):

1. **Provide approximated channel cross sections for all NBIS length bridges and state-owned structures with structure lengths greater than 8 feet over water with 1A05 ≤ 3 , including bottomless culverts.**

2. **Obtain additional channel cross sections of the channel at locations where:**
   - Channel alignment is Poor (IN10 ≤ 4) or
   - When channel erosion, sloughing, cut banks, etc. has occurred or
   - When channel lateral migration or meandering has occurred or
   - Channel is unstable and threatens the bridge waterway opening

3. **Update existing cross sections drawings for this purpose if acceptable existing cross sections are available from:**
   - Design H+H Reports.
   - Observed Scour Assessment (OSA) by USGS.

4. **Mark any new channel changes on the previous cross sections from the bridge inspection file to establish trends.**

5. **Channel cross sections for larger streams and rivers (streams wider than 200' at normal flow) may be more resource intensive than needed for routine inspections of bridges. Consideration may be given to:**
   - Limiting the cross section to the vicinity of substructures susceptible to scour.
   - Limiting the update of a channel cross section to the portions near substructures susceptible to scour.

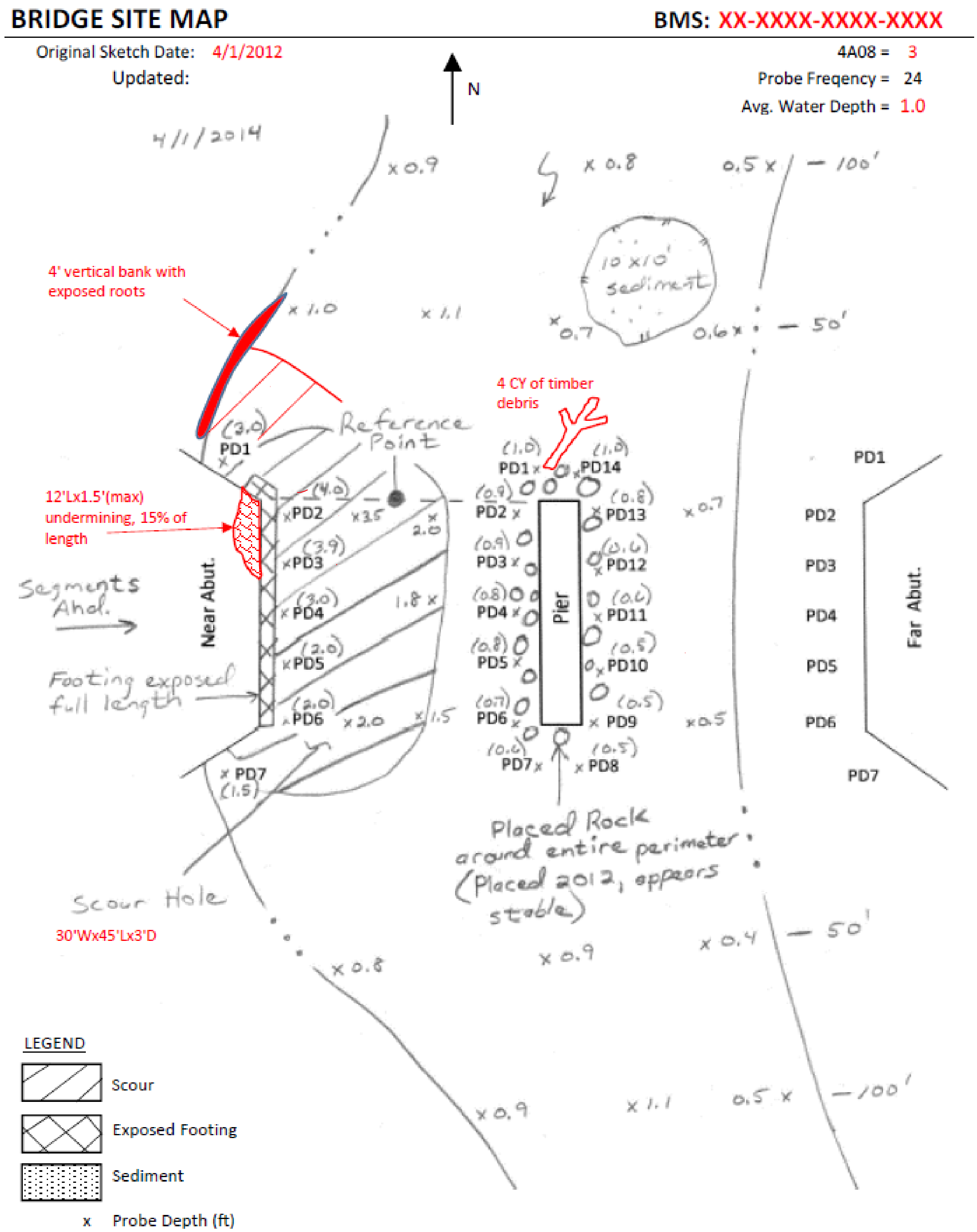
For scour critical bridges, these channel cross section limitations indicated above, may not provide sufficient channel bottom information for analysis and the extent of information required may be greater.

6. **Channel cross sections should:**
   - Be completed in table format, such as a spreadsheet, and stored in BMS2 Documents.
   - Be located on a site map.
   - Include a minimum of one cross-section upstream and one downstream. Cross-sections from most cases can be approximated with lateral streambed measurements and soundings.
   - Be clearly marked between two landmarks, such as trees or other features likely to remain stationary. Landmarks shall be documented with information such as diameter of tree, approximate location from the bridge, and photographs shall be included to document the landmarks for future inspections.
   - Include lateral measurements to the edge of water at the substructure corners.
   - Approximately be parallel to the roadway.

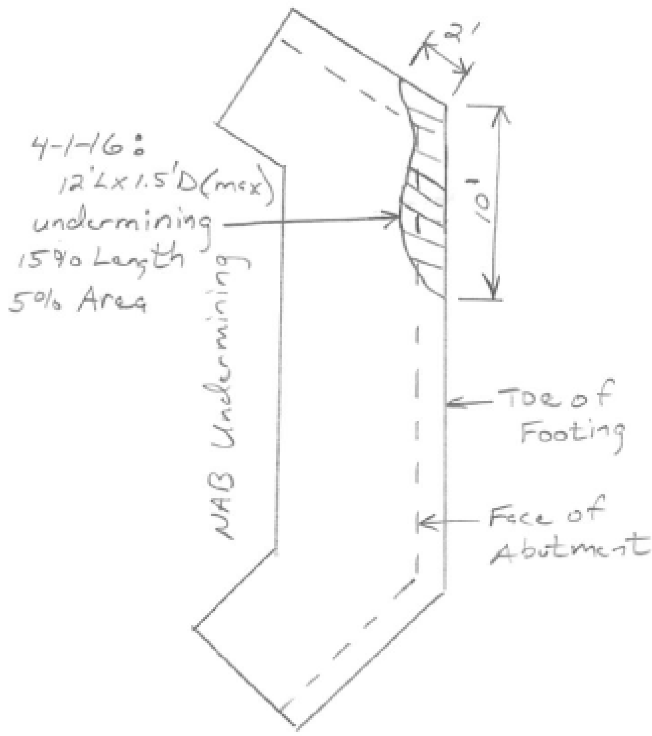
EXAMPLE 1 – SAMPLE SCOUR DOCUMENTATION:

Note: A sample spreadsheet template will be made available by PennDOT Central Office.

I. SITE MAP:



Undermining Detail (Provide as needed to document undermining and track changes):



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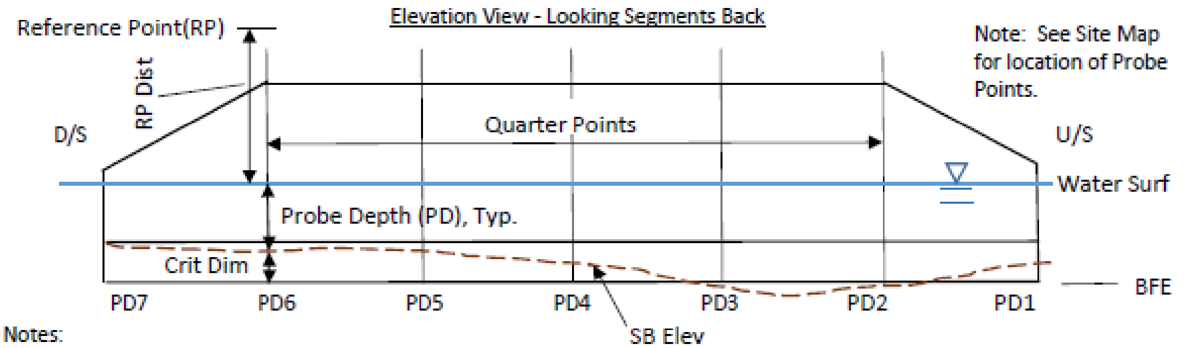
II. Streambed Probes at Substructure Units:

Streambed Probes at the Near Abutment **BMS: XX-XXXX-XXXX-XXXX**

BFE = 82 (Calculated from Plans xxxxx) Reference Point (RP) = Top of Barrier at Span 1 Midspan
PTE = NA Reference Point Elev = 100 (From Design Drawings)



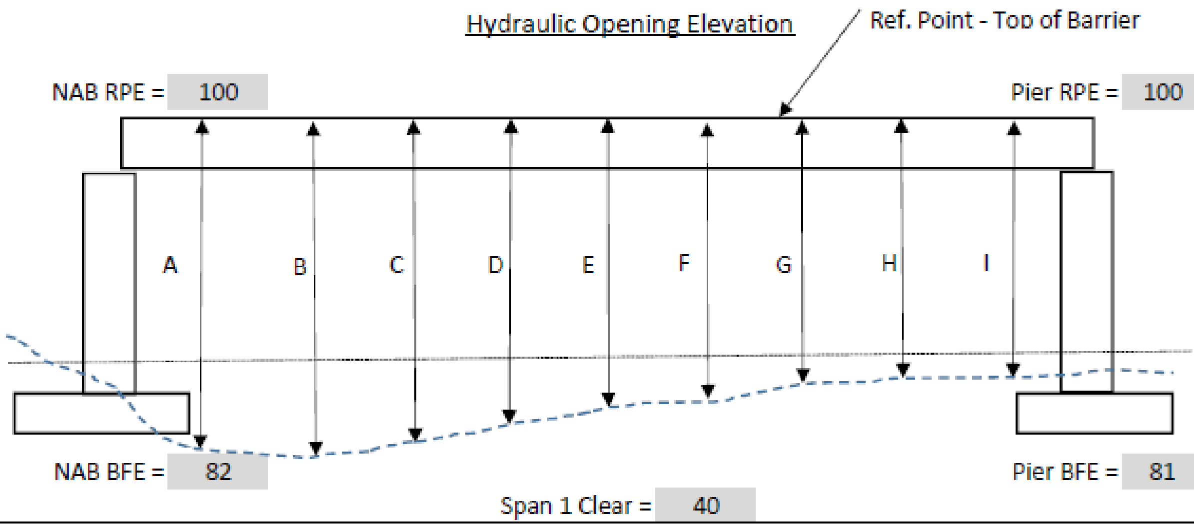
Notes:

Probe Depth (PD) = Total depth probed when in water = water depth + infill
Note: When probed depth is above water, record the distance as (-)
Use additional Probes between the Quarter Point probes as needed.
* SB Elev = Reference Point Elev. - RP Dist - Probe Depth = Streambed Elevation
** Crit Dim= SB Elev - BFE = Distance from probed streambed to the BFE
***Undermine = Horizontal undermining from the front face of the footing (Field Meaured)
RP Dist = Distance between the reference point and water surface.

Date	PD7		PD6		PD5		PD4		PD3		PD2		PD1	
4/1/12	0.5		1		1.5		1.8		2		2.1		0.5	Probe Depth
	86.0		85.5		85.0		84.7		84.5		84.4		86.0	* SB Elev
Base	4		3.5		3		2.7		2.5		2.4		4	** Crit. Dim
Year	0.0		0.0		0.0		0.0		0.0		0.0		0.0	***Undermine
	Notes: Minor Scour, Footing Not Probed												RP Dist =	13.5
4/1/14	1		1.2		1.3		1.5		2.5		2.5		1.8	Probe Depth
	85.0		84.8		84.7		84.5		83.5		83.5		84.2	* SB Elev
	3		2.8		2.7		2.5		1.5		1.5		2.2	** Crit. Dim
	0.0		0.0		0.0		0.0		0.0		0.0		0.0	***Undermine
	Notes: Advanced Scour, Footing Probed for 15' and exposed up to 0.5'.												RP Dist =	14.0
4/1/16	1.5		2		2		3		3.9	4.2	4	3.8	3	Probe Depth
	84.0		83.5		83.5		82.5		81.6	81.3	81.5	81.7	82.5	* SB Elev
	2		1.5		1.5		0.5		-0.4	-0.7	-0.5	-0.3	0.5	** Crit. Dim
	0.0		0.0		0.0		0.0		0.5	1.5	1.0	0.5	0.0	***Undermine
	Notes: Serious Scour, Footing undermined up to 18" deep over 15' length. 15% of the length is undermined.												RP Dist =	14.5
														Probe Depth
														* Elev
														** Crit. Dim
														***Undermine
	Notes:												RP Dist =	14.5
														Probe Depth
														* Elev
														** Crit. Dim
														***Undermine
	Notes:												RP Dist =	

III. Bridge Waterway Cross Sections

Bridge Waterway Cross Section at Bridge Opening **BMS: XX-XXXX-XXXX-XXXX**



Notes:
BFM = Bottom of Footing Measurement = RPE - BFE
Measurements are from top of barrier to streambed
Elevations are from Design Drawings XXXXX.

# of Points
Small Spans (<30') - 3 Points
Med. Spans (30' to 200') - 5 to 9 Points
Large Spans (> 200') - Tenth Points of Span

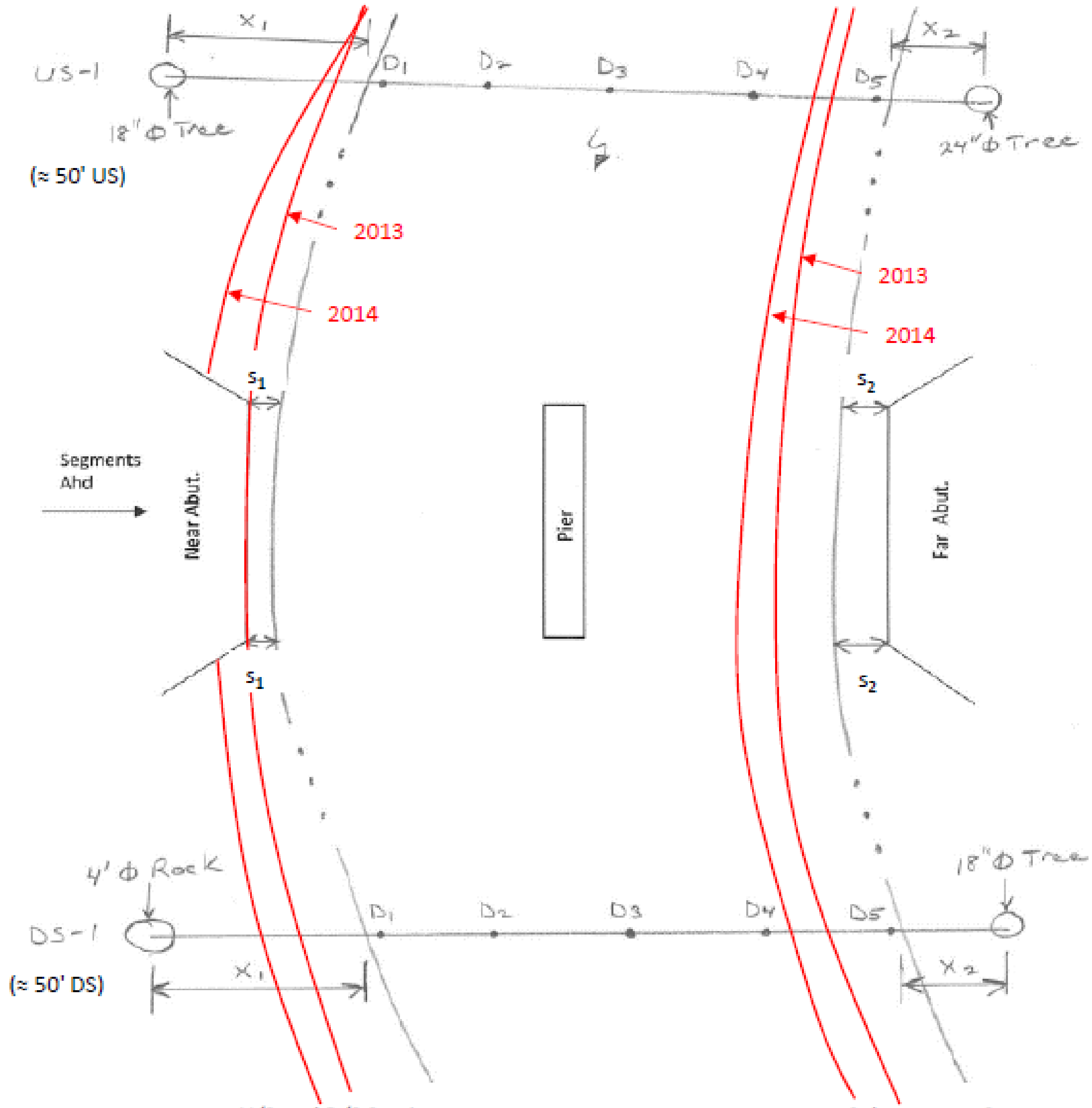
U/S READINGS - Span 1									
Point	A	B	C	D	E	F	G	H	I
% Span	0	0.125	0.25	0.375	0.5	0.625	0.75	0.875	1.00
Distance (ft)	0	5	10	15	20	25	30	35	40
BFM	18								19
4/1/12	17.5		18		16		16		15.5
4/1/14	18		18.5		16.5		16		15.5
5/24/15 Flood	18.5								15.5
4/1/16	18.5		19		17.5		16		15.5

D/S READINGS - Span 1									
Point	A	B	C	D	E	F	G	H	I
% Span	0	0.125	0.25	0.375	0.5	0.625	0.75	0.875	1.00
Distance (ft)	0	5	10	15	20	25	30	35	40
BFM	18								19
4/1/12	14.5		15		16		16		15
4/1/14	15		16		16.5		16		15
5/24/15 Flood	16.5								15
4/1/16	16.5		17		17		16		15

IV. Channel Cross Sections

Channel Cross Section **BMS: XX-XXXX-XXXX-XXXX**

Original Sketch Date: 4/1/12 Channel Cond., IA05 = 3 Monitor Freqency = 12 months



U/S and D/S Sections

Location	Date	Water x_1	x_2	Water Depth D_1	D_2	D_3	D_4	D_5
US-1	4/1/12	15	10	2	3	3	1	1
	4/1/13	13	12	2	3.5	3.5	1	0
	4/1/14	11	13	2.5	4	4	1.5	0
DS-1	4/1/12	18	8	1	2	2	2	1
	4/1/13	16	10	1	2.5	3	2	0
	4/1/14	14	12	1.5	3	3	2.5	0

Substructure Corners

Location	Date	Dist. To Water s_1	s_2
US Bridge	4/1/12	2	3
	4/1/13	0	5
	4/1/14	-4	9
DS Bridge	4/1/12	2	3
	4/1/13	1	4
	4/1/14	-2	7

APPENDIX IP 02-F

Action Plan for Emergency Bridge Closure

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Publication 238 (2021 Edition), Appendix IP 02-F
Action Plan for Emergency Bridge Closure

STATE OWNED STRUCTURES			
	ACTION	***RESPONSIBLE PERSON***	***EXPECTED RESULTS***
1	Establish need for emergency structure closure.	Inspection Team Leader	Record Basic Information for Step 2 - Photograph of deficiency - Location and probable cause of deficiency - Structure type and affected structural member - Do you have required resources to safely close the bridge?
2	Make notification to PennDOT's District Bridge Unit	<u>Department Inspection Team:</u> Inspection Team Leader <u>Non-Department Inspection Team:</u> Professional Engineer and Inspection Team Leader	Contact the Assistant District Bridge Engineer - Inspection and notify of need for closure - Provide Basic Information from Step 1 - Consult on the need for closure - Discuss resources available to close the bridge - Adequate sight distance (Refer to Item 4A02) - Vehicle properly equipped (amber lights)
3	Make notification to County Maintenance	District Bridge Engineer or Assistant District Bridge Engineer - Inspection	Inform County Maintenance of the incident - Provide location of the structure - Identify a contact person on-site and in the office
4	Identify the detour route	County Maintenance Manager, Assistant County Maintenance Manager or District Traffic Engineer	Develop detour using state routes
5	Complete the bridge/road closure and implement detour	Assistant County Maintenance Manager or Highway Foreman	Stop vehicular and pedestrian traffic from using the structure above and below - Place signage and trucks to block traffic at either end of the structure - Implement the detour in the field
6	Send notifications to the outside public	County /Assistant County Maintenance Manager and Community Relations Coordinator	Make notification to the County 911 center Enter an RCRS Event
7	Develop a Plan of Action and Bridge Problem Report	District Bridge Engineer or Assistant District Bridge Engineer - Inspection	Complete a Bridge Problem Report and Plan of Action Send POA and BPR to the Bridge Inspection Section Chief

NON-PENNDOT STRUCTURES			
	ACTION	***RESPONSIBLE PERSON***	***EXPECTED RESULTS***
1	Establish need for emergency structure closure.	Inspection Team Leader	Record Basic Information for Step 2 - Photograph of deficiency - Location and cause of deficiency - Structure type and affected structural member - Do you have required resources to safely close the bridge?
2	Make notification to the bridge owner and PennDOT's District Bridge Unit	Professional Engineer and Inspection Team Leader	Contact the bridge owner and Assistant District Bridge Engineer - Inspection and notify of need for closure - Provide Basic Information from Step 1 - Consult on the need for closure - Discuss the ability to use vehicle to stop traffic - Adequate sight distance (Refer to Item 4A02) - Vehicle equipped with amber lights
3	Make notification to Municipal/County Maintenance or Traffic Control Provider*	Municipal/County owner or Professional Engineer	Secure Traffic Control for Closure - Provide location of the structure - Identify a contact person on-site and in the office
4	Identify the detour route	Municipal/County owner	Develop detour using local routes
5	Complete the bridge/road closure and implement detour	Municipal/County Maintenance Force or Contracted Traffic Control	Stop vehicular and pedestrian traffic from using the structure above and below - Place signage and trucks to block traffic at either end of the structure - Implement the detour in the field
6	Send notifications to the outside public	Local owner or Professional Engineer	Make notification to the County 911 center Develop a press release
7	Develop a Plan of Action	Professional Engineer and Inspection Team Leader	Complete a Plan of Action and meet with the Bridge Owner Send the Plan of Action to the Assistant District Bridge Engineer - Inspection
8	Develop a Bridge Problem Report	Assistant District Bridge Engineer - Inspection	Complete a Bridge Problem Report and send to the Bridge Inspection Section Chief Make notification to District Bridge Engineer

* If local owner is not available or fails to respond, solicit assistance from the District Bridge Engineer as indicated in Publication 238, IP 02.14.

APPENDIX IP 02-G

Inspection Procedures Following
Emergency Events

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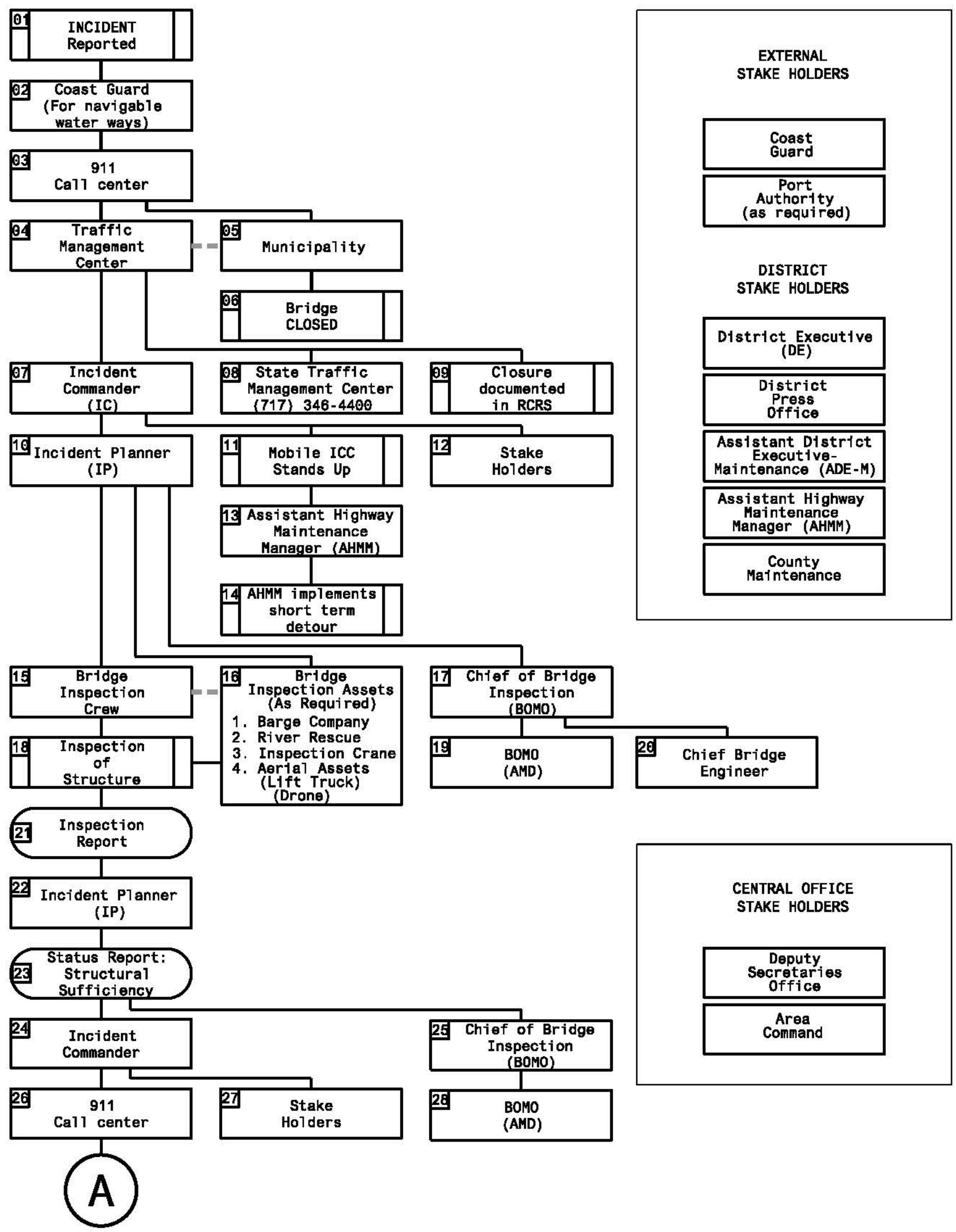
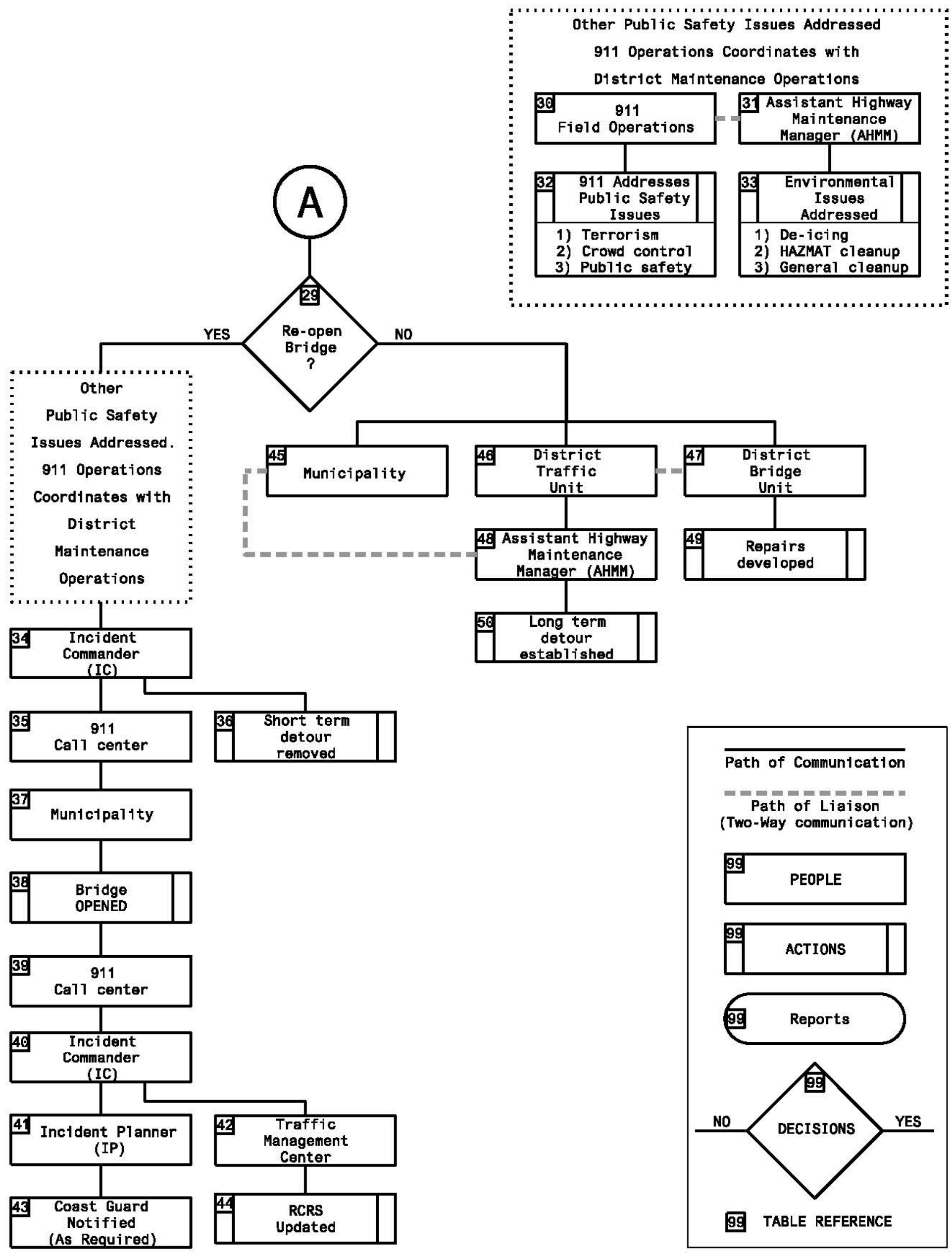
Sample Communication Flowchart for Emergency Bridge Event (1 of 2)

Example shown is for a barge hit, but the chart can be modified for other events.



Sample Communication Flowchart for Emergency Bridge Event (2 of 2)

Example shown is for a barge hit, but the chart can be modified for other events.



Post-Seismic Event Bridge Inspection Guidelines (1 of 2)

Seismic events are complex in nature and it is difficult to develop stringent protocols. With that said, PennDOT has used recent seismic events within our State as well as lessons learned in nearby States to develop guidelines for inspecting bridges after a seismic event has occurred.

Notification

The Bridge Inspection Section (BIS) receives notifications directly from USGS via their website (https://earthquake.usgs.gov/earthquakes/). Other bridge inspection staff are encouraged to also enroll in notifications. Notifications may also originate from an Emergency Management Center. Upon notification, the BIS will ensure that the following individuals are alerted:

- Deputy Secretary Highway Administration
- Director, Bureau of Maintenance and Operations (BOMO)
- Director, Bureau of Project Delivery (BOPD)
- Chief Bridge Engineer
- Asset Management Division Chief
- District Executives affected
- District Bridge Engineers affected

Seismic Response Levels

Pennsylvania has dealt with seismic events in its history; however, a reliable record of bridge damage resulting from seismic events does not exist. Therefore, it is difficult to analyze and set a threshold for when there is a greater likelihood of damage. Utilizing recent seismic events in and near PA as well as other States' guidelines, the four response levels outlined in the table below can be followed.

Table IP 02-G–1 Seismic Response Levels

Response Level	Earthquake Magnitude	Radius of Concern	Description of Response
1	< 3.5	-	No follow-up inspection warranted. Limited inspection scope may be deemed necessary by BIS on a case-by-case basis.
2	3.5 to 4.5	20 mi	Preliminary inspection of all infrastructure located in the radius of concern. Can be performed by bridge inspection or maintenance personnel. Inspections are cursory in nature.
3	4.6 to 5.5	50 mi	Thorough inspection by qualified NBIS inspector of structures located in the radius of concern. Similar in scope to a damage inspection. Access means shall be coordinated if required.
4	> 5.5	100 mi*	Thorough inspection by qualified NBIS inspector of structures located in the radius of concern. Similar in scope to a damage inspection. Access means shall be coordinated if required. Closures are expected due to higher likelihood of infrastructure damage.

*For higher magnitude earthquakes the radius of concern may be adjusted on a case by case basis as determined by the Bridge Inspection Section Chief.

Post Seismic Event Bridge Inspection Guidelines (2 of 2)

Bridge Inspection Criteria

Once the response level has been determined, the Bridge Inspection Section will distribute the list of affected structures to the District Bridge Engineers. These lists are assembled using the following criteria:

- Bridges with rocker bearings
- Bridges with any individual span >200'
- Bridges with pier heights > 60'
- Fracture critical bridges
- Curved bridges
- Other bridges based on intensity, location, and depth
- Tunnels, sign structures, retaining walls and high mast lights may be included for response levels 3 and 4.

Districts may be asked to provide information on bridges in staged construction or shored state.

Inspections will be considered Damage Inspections and shall only be performed during daylight hours to allow for clear visibility and hands-on inspections if necessary.

During the inspections, focus should be on the follow areas of concern:

- Deck joints for lateral movements or unusual longitudinal movements
- Bearings for excessive tilt
- Unusual cracking in deck, superstructure or substructure
- Settlement of approach roadway pavement that could indicate global instability
- Damage to pin and hanger assemblies
- Damage to attached utilities or supports (e.g. gas or water lines)

In the instance of a Response Level 4 affecting a large population of bridges, prioritization of inspection will be as follows:

1. Interstates
2. NHS Routes
3. Non-NHS

If seismic related damage is found, the District Bridge Engineer should be notified immediately. The Bridge Inspection Section Chief and BOMO Director should then be notified as soon as possible. If closure is warranted, it shall be done immediately.

Post Fire Evaluation Guide

A fire event associated with a bridge, the Incident Command Organizational Structure is implemented. In support of the Incident Commander, the District Bridge Engineer shall:

1. Assess the safety of the bridge regarding safety of vehicles both civilian vehicles and fire equipment on the bridge

2. Assess the safety of the bridge to determine if the bridge can be reopened to traffic

Some types of damage are obvious, such as large deflections, bearing damage, collision damage, buckling of members, and other visually detectable degradation. There is also a possibility of hidden damage due to degradation of material properties.

This Guide provides information on fire effect to steel and concrete properties, inspection guidance, material testing guidance and results of investigations into 2 fire damaged steel bridges.

1. Overview of Structural Behavior from the Effects of Fire

Understanding the high temperature structural response of bridges is useful for predicting behavior prior to fire events. The maximum deflection at high temperatures is determined by thermal expansion effects, reduced material strength, the reduced modulus of materials at high temperatures, and the effects of creep. When the structure cools after the fire event, a substantial amount of this deflection recovers. It is even possible in some cases to have some positive residual camber if localized yielding occurs during the fire. If the deflection recovers, the geometry of the bridge is still suitable for its intended traffic use. Any effect on load rating needs to be determined based on a survey of localized damage and post-fire material properties. Predicting the maximum high temperature deflection of structures is interesting, but the most important aspect is to determine/measure the presence of permanent deformation after the fire.

An engineering assessment is required to evaluate the post-fire strength and serviceability of the bridge structure. Any permanent deflections will be obvious, and their impact can be assessed without the need for high temperature modeling. However, high temperature modeling can be useful to develop a better understanding of material temperatures during the fire. There is substantial information available in the literature that can be used to predict the post-fire material properties based on the temperature reached during the fire event. Fire simulation modeling provides a benchmark for predicting the material temperatures that occurred during the fire. The fire simulation modelling is a specialized analysis and is warranted in certain circumstances as determined by District Bridge Engineer.

Thermal expansion may be the most important thermal property for structural response prediction at high temperatures. Large thermal strains and strain incompatibilities between different parts of the structure are a primary cause of global deflection and localized damage. The coefficient of expansion of steel increases at elevated temperatures. The thermal conductivity of steel is about 30 times greater than concrete. Therefore, concrete tends to heat up internally much slower than steel when exposed to the same surface temperatures. This effect is very beneficial to prevent or delay strength loss in concrete beams and bridge decks.

Fire suppression efforts can worsen bridge damage during fire events. Water applied directly to hot steel or concrete members can sometimes cause more damage than letting the members cool slowly. For steel members, quenching localized areas with water can induce large temperature gradients that may create local buckling and distortion. There is also the possibility that water may act as a quenching agent on the material. Quenching can be expected to alter the properties of some steels that may impair their fitness for continued service in the structure. Water spray on hot concrete members can accelerate cracking and spalling during the fire event. The strength of concrete members depends in part on the integrity of the reinforcing steel. Having concrete cover protects the steel from direct exposure to heat. Rapid quenching with water can cause cracking and spalling of the concrete cover thereby exposing the reinforcement to higher temperatures. In general, fire fighters should be directed to avoid spraying water directly on the bridge superstructure. Obviously, there may be more important issues than preventing bridge damage during the fire event. For fires occurring underneath a bridge the suppression should be directed to the base of the fire. It may not be possible to avoid spraying the bridge when fires are located on the bridge deck. In this case, the best approach is to avoid, as much as possible, spraying the beams underneath the bridge.

Infrared photography may also be useful to assess bridge temperature during the fire. The presence of smoke and flames during the peak fire times may block the effectiveness of this method. However, infrared information at the beginning of the cooling phase would be very useful.

1.1 *Fire Location*

The location of the fire has a significant effect on the deflection response of the bridge. Since the strength and stiffness of the members is proportional to their temperature and the fire location determines how the different members are heated, the fire location directly determines the distribution of weakened members in the structure.

Studies have shown that it is inaccurate to assume that the surface temperature of bridge members equals the gas temperature of the fire. On an average, the severe fire simulations performed in the NCHRP 12-85 study show gas temperatures around 1400°C (2552°F) for a typical gasoline tanker fire while the maximum steel temperature only reached about 700°C (1292°F) and held relatively steady at that level.

For bridges without structural members above the deck level, fires contained on bridge decks do not cause any significant heating of the bridge members below the deck. Most of the heat is directed upward and the deck concrete has relatively low thermal conductivity. This protects the underlying members from heat. It is important to recognize that fires involving fuel spills may also extend underneath the bridge. Liquid fuel will follow the normal drainage path for rain water and can cause significant fire underneath the bridge.

Bridges with support structure above deck level, such as through trusses and cable supported structures, may have structural damage from fires confined to the roadway deck. Any structural member that is exposed to direct flames for more than a few minutes may be vulnerable to fire damage. Guidance developed from girder temperature in NCHRP 12-85 Research Report for the 14 case studies may be useful to estimate temperatures versus time for truss members exposed to flames. Cables are not directly covered by this Guide, but some information is available in the NCHRP 12-85 Research Report.

Fires located in the center underneath of the bridge, both longitudinally and transversely cause the largest vertical deflection. For this case, the maximum heating occurs at the point where the girders have maximum moment due to loading. The exterior girders receive less heating since the fire typically does not wrap around the exterior face of the girders. There is a general reluctance for flames to spread transversely across the bridge due to the projection of the girders. It is much easier for flames to spread longitudinally. The center location causes strength reduction in most of the interior girders and the two exterior girders will carry most of the load in the latter fire stages. The bridge width and number of girders will have a substantial effect on transverse fire spread. Wider bridges will have even less heating on the exterior girders and more redundant load paths to support the weakened girders.

2. Post Fire Inspection

1. Development of an overall flame spread map is the first step to developing a plan to proceed with evaluation of the bridge. See Figure 1.
2. In general, the overall flame spread mapping should define regions of the structure into at least three categories relative to fire exposure:
    a. regions with no direct contact with flames;
    b. regions with intermittent or lapping flame contact and
    c. regions with continuous flame contact.
3. A significant fact that will aid post-fire strength evaluation is knowing the maximum temperature of the bridge members but is difficult to quantify. The primary variables are full source and vertical offset. See Table 1 for data from NCHRP 12-85.

   The purpose of this mapping is to focus the post-fire inspection on the regions with the highest potential for material damage. Regardless of fire exposure, physical damage may exist in other parts of the structure due to thermal expansion and distortion of members. Therefore, a detailed structural inspection of the entire structure is suggested, regardless of the flame spread map. See Section 5 for instructions of components to be inspected post fire. The presence of physical cracking and distortional damage can be readily assessed by detailed visual inspection and the consequences of such damage shall be evaluated by the District Bridge Engineer.

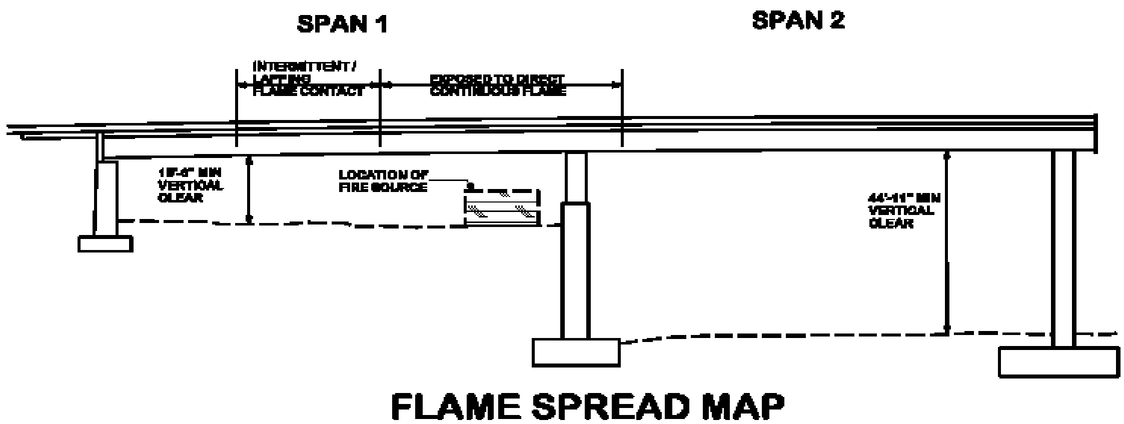


Figure 1 – Flame Spread Map

Table 1 – NCHRP 12-85 Benchmark Fire Simulations

Case No.	Vehicle Type	Fire Location	Beam Material	Vertical Clearance (ft)	Maximum Heat Release Rate (MW)	Event Duration	
						Heating Phase (seconds)	Cooling Phase (seconds)
1	Bus	A	Steel	16	40	5000	3600
2		B	Steel	16			
3		C	Steel	16			
4	HGV	A	Steel	16	210	2500	6100
5	Half HGV	A	Steel	16	105	2500	6100
6		B	Steel	16			
7		C	Steel	16			
8	Tanker	A	Steel	16	295	3000	5600
9		B	Steel	16			
10		C	Steel	16			
11	Tanker	I-65	Steel	16		2650	5950
12	Tanker	A	Steel	24			
13		A	Concrete	16			
14		A	Steel	32			

3. Steel

3.1 *Carbon and Low Alloy structural steels:*

Assuming a structure does not collapse in a fire event, the residual properties of steel must be understood to evaluate the post-fire safety of the structure. It is possible for steel to sustain damage in the fire event that will alter its residual properties. However, damage is only expected for cases with extreme fire exposure. The extent of damage depends on the intensity and duration of the fire, the geometry of the structure, the type of material, and the type of load on the members. The best way to assess structural integrity after a fire is to measure the material properties. However, this requires destructive testing that may not be warranted or practical in most cases. This is because common structural steel grades generally do not show much, if any, post-fire strength reduction unless the reach very high temperatures approaching the melting point.

The most common steel grades present in bridges are A709 Grades 36, 50, and 50S. These steels are typically heated to around 1000°C during the rolling process and allowed to air cool at the mill. The steels have relatively low hardenability indicating that the mechanical properties are relatively insensitive to heat treatment. As appoint of reference, the phase transformation temperature is around 725°C (1337°F) where the grain structure may be changed through heating and cooling.

Most fire events involving small vehicles or limited size fires in trucks are not expected to cause temperatures that reach the threshold of possible steel damage. Studies have shown that there is little change in the post-fire strength properties when heating is kept below about 700°C (1292°F). A PennDOT study, Effects of Fire Damage on the Structural Properties of Steel Bridge Elements, April 30, 2011, confirms that the post-fire properties of A709 Grade 50 structural steel are unaffected following heating to 650°C (1202°F). See Section 3.6 for hyperlink to the study report.

Statistically, the average yield strength of undamaged structural plate is about 8% higher than the nominal strength used for design. Therefore, even if there is a slight post-fire strength reduction, most steel members will still exceed their nominal design strength also still meet the required load rating with a slightly reduced yield strength, depending on what limit states govern the design.

The presence of distortion is another piece of evidence that can indirectly indicate the post-fire properties of steel. An AISC report indicates that members heated beyond 700°C will usually show large deflection or localized distortion when heated in a structural system. Such distortion may require remediation or repair that lessens the need to evaluate strength. The models run in the NCHRP 12-85 research showed substantial web buckling when the steel temperature exceeded about 600°C (1112°F).

Typical severe bridge fire, that it is difficult to reach steel temperatures exceeding 700°C (1292°F) without large deformation or collapse.

Based on the information generated in the NCHRP 12-85 project and that available in the literature, the following recommendations are made for evaluating the strength of structural steel with Fy ≤ 50 ksi:

• Steel heated to temperatures at or below 700°C (1292°F) can be considered to have no reduction in strength following fire exposure.

• Steels subjected to temperatures exceeding 700°C (1292°F) but less than 1000°C (1832°F) can be conservatively estimated to have a 10% reduction in both tensile and yield strength. If this is a cause for concern after load rating the post-fire bridge, mechanical property testing may be indicated to determine a more refined estimate of steel strength.

The available evidence shows that steels heated to temperatures below 650°C (1202°F) will not have any significant loss in CVN toughness. Therefore, post-fire evaluation generally should not include CVN testing. A thorough hands-on visual inspection of heat affected weldments is required. Distortion and high forces due to thermal expansion can cause cracking or distress of welds. However, some bridge members, such as those classified as fracture critical, may present a higher concern for CVN toughness evaluation. In these cases, destructive CVN testing is the only option available to determine fitness for service.

3.2 *Heat Treated Steels*

Heat treated steels require extra caution in the post fire strength evaluation process. ASTM A709 grades HPS 50W, 50W, HPS 70W, and HPS 100W have higher hardenability compared to low-alloy structural steels. This indicates that the mechanical properties are more dependent on the heating and cooling rate history. Grades HPS 70W and HPS 100W rely on some form of heat treatment in the manufacturing process to develop mechanical properties.

Grades HPS 50W and 50W are not classified as heat treated steels since no heat treatment is used in the manufacturing process. However, the chemistry is very similar to heat treated grades (70W, and HPS 70W) that add heat treatment to boost properties. From a strength perspective, grades 50W and HPS 50W can be expected to have little or no strength loss or mechanical property loss following fire exposure. They can be expected to perform similar to low alloy steels. However, rapid cooling during the fire process, such as from direct exposure to water from fire hoses, may have a quenching effect on the steel resulting in strength elevation. In general, HPS 50W and 50W steels should be evaluated as low alloy steels for strength and toughness. If there is evidence that the steel was subjected to high cooling rates from heavy application of water, further evaluation of toughness is required.

In general, the AWS D1.5 Bridge Welding Code allows heat forming operations for quenched and tempered steels as long as the heating temperature falls below the tempering temperature used in manufacturing. AWS conservatively limits the maximum temperature during heat forming operations to 600°C (1112°F) for the HPS grades.

Based on the information gathered in the 12-85 project and that available in the literature, the following recommendations are made for evaluating the strength of heat-treated structural steel with Fy > 50 ksi:

• Heat treated steel heated to temperatures at or below 600°C (1112°F) can be considered to have no reduction in strength following fire exposure.

• Heat treated steels subjected to temperatures exceeding 700°C (1292°F) are expected to have a significant loss of strength and require further evaluation.

• Heat treated steels that reach temperatures between 600°C (1112°F) and 700°C (1292°F) may experience strength loss or toughness degradation and require further evaluation.

3.3 *High Strength Bolts*

High strength bolts should be classified as heat-treated products for strength evaluation. Grade A325 and A490 structural bolts are heat treated during manufacture to obtain their mechanical properties. Heating above 600°C may alter the tensile strength and ductility of the bolts. Any bolted connections designed for strength should be subjected to further evaluation if it is suspected that the girder temperature exceeded 600°F (1112°F) at the connection location. Unlike steel girder plate material, bolt strength is relatively easy to evaluate by removing a sampling of bolts from the connection and testing the bolts.

The results show that it is inaccurate to assume that the surface temperature of bridge members equals the gas temperature of the fire. On an average, the severe fire simulations performed in the NCHRP 12-85 study show gas temperatures around 1400°C (2552°F) for a typical gasoline tanker fire while the maximum steel temperature only reached about 700°C (1292°F) and held relatively steady at that level.

3.4 *Fatigue and Fracture*

Fatigue life can be divided into two phases, a crack initiation phase and a crack propagation phase. Most of the life is spent in the initiation phase where no finite size cracks are present at the detail. Fire events cause very large thermal expansion of some steel members. This results in very high forces in members that are interconnected. In some cases, these forces can overstress fillet welds and introduce localized cracking. If such cracks are present, this shortens the initiation phase and can lead to premature fatigue failure. It is therefore important to perform a "hands-on" inspection of fillet welds in steel bridges that have substantial exposure to fire. The same procedures used for fracture critical inspection should be followed. The overstressing effects of thermal expansion may extend beyond the heating area of the fire. Therefore, any parts of the bridge that may be affected by thermal expansion should be inspected. This includes regions in compression that are not normally evaluated for fatigue. If it can be verified that no cracks were introduced during the fire, then fatigue life should not be reduced.

Research on heat straightening of steel members does not show any special concerns for CVN toughness in grade 36, 50, 50W, or 50S steel. Therefore, for typical girder bridges with redundant (non-fracture critical) members there is no evidence to suggest that fire will impair fracture toughness.

3.5 *Structural Analysis*

The structural analysis of a bridge due to fire damage can vary in the level of complexity. A structural analysis if warranted shall be conducted per direction of the District Bridge Engineer. The structure can be modeled as a line girder with the reduced properties of steel at 700°C (1292°F) in the appropriate regions determined by observation of the fire event. In many cases, the mechanism may predict structural collapse. This can be used as a relatively quick reality check that may invalidate or validate temperature prediction from other methods. A structural "reality check" is useful to prevent over-estimation of temperatures that can lead to over-estimation of structural damage. For an advanced analysis for fire effects describing Fire Modelling, Heat Transfer Modeling and Structural Modeling please refer to report ATLSS-18-03 NUMERICAL EVALUATION OF A SAMPLE STEEL GIRDER BRIDGE FOR A CONSTRUCTION TRAILER FIRE UNDERNEATH.

3.6 *Paint Condition:*

The condition of the paint on steel girder bridges can provide a rough estimate to the intensity of the temperature that the girders were exposed. A general study was performed by PennDOT looked at several different coating systems in a more controlled furnace environment. A series of photographs show the condition of coatings heated to different temperatures that can serve as samples for use by bridge inspectors. Practical application of this approach may be hampered by smoke and soot from other combustible material in the fire event. The report is at:

http://www.dot7.state.pa.us/BPR_PDF_FILES/Documents/Research/Complete%20Projects/Maintenance/Effects%20of%20Fire%20Damage.pdf

3.7 *Destructive Testing*

Destructive testing is the most accurate way to determine the residual properties of steel after fire. Performing tension tests according to ASTM E6 procedures provides an accurate assessment of the post-fire strength and ductility of steel. However, this requires removing samples of material from the web and flange plates, often in critical structural areas. The cost of testing therefore may be large since structural repairs may be required following removal of test specimen. Sometimes it may be possible to test stiffeners, or other secondary members without causing damage that is costly to repair. Consideration needs to be given if the secondary member material is different than the primary member material of concern. It is also possible to test sub-size specimens that can be machined from a 4 in core drilled from the material. Sub-size specimens can introduce a size effect that must be considered when comparing results to the standard size specimens used for structural steel testing. Refer to case study 2 for material testing performed on the Dauphin County SR 322 bridge.

4. Concrete

The post-fire strength of concrete does not recover like the post fire strength of steel when the material cools down. This indicates that strength loss in concrete due to heating is a permanent after effect of fire.

In general, spalling will be either visually obvious following a fire event. This will not be a hidden problem; therefore, the strength consequences can be addressed in terms of section loss and effects on the development capacity of the reinforcing steel.

An indicator of the level of heating that the concrete has experienced is the color of the aggregates.

500 F spalled/exposed concrete surface will appear to have a pink/red color.

900 F spalled/exposed concrete surface will appear to have a purple-gray color

The response of mild steel reinforcement in concrete is similar to structural steels. No post-fire reduction in strength is expected as long as the temperature does not exceed 700°C (1292°F). There will also be severe concrete damage at this temperature it is unlikely that there will be any "hidden" reinforcing bar strength loss that needs to be considered in post-fire strength evaluation.

Estimation of temperature in concrete members is more important than steel members as the expected concrete damage is permanent. The prestress loss and the post fire strength of strands is also very dependent on temperature. An analysis performed under NCHRP 12-85 shows the predicted surface temperatures and predicted temperatures within the concrete beam. Table 2 shows the internal departures decrease at greater depths.

Table 2 – Predicted internal temperatures of PS Concrete beam

Girder	Surface Temperature		Internal Temperature at 2" Cover		Internal Temperature at 4" Cover		Internal Temperature at 6" Cover	
	(°C)	(°F)	(°C)	(°F)	(°C)	(°F)	(°C)	(°F)
1	830	1526	425	797	200	392	180	356
4	1050	1922	525	977	270	518	180	356

For these beams, the bottom strand layer is located 2 in. above the bottom surface. The exterior girder (girder 1) is not expected to have much strand strength reduction in the bottom strand layer located 2 in. above the bottom surface. The interior girder (girder 4) might be expected to have about a 30% strength reduction in the bottom strands. No strength reduction is predicted in the upper strand layers in either girder. Therefore, even for the most severely exposed interior girder, most of the strands are expected to retain their pre-fire capacity.

A prestressed girder bridge that was damaged by a train fire was the Puyallup River Bridge in Washington State reported by Stoddard (Stoddard, 2004). The prestressed girders were engulfed by a large ethanol fire for a fire duration of about one hour. Post fire testing indicated there was no detectable loss of prestressing force in the exposed tendons at the bottom of the beam.

4.1 *Non-Destructive Testing/Observation*

Degradation of the concrete cross section due to delamination and/or spalling can be easily detected by a detailed post-fire inspection. Spalling where the concrete has fallen off is easy to visually detect. Sounding the concrete with a hammer can detect delaminations that indicate the early stages of spalling. Data is available in the literature relating the color of concrete to post-fire compression capacity. A pinkish hue generally serves as an indication of altered material properties. Tests such as rebound hammer may also be useful to evaluate concrete strength.

Cracking in tension areas of prestressed concrete members provides a strong indication that there is a loss of effective prestressing force. Open cracks will be accompanied by measurable vertical deflection and are a clear sign that the prestressing force has been compromised. Tight cracks with no apparent vertical deflection are more difficult to evaluate since they may have been formed by thermal expansion at high temperature. In this case, visual crack observations should be corroborated with other assessment means such as temperature estimation.

4.2 *Destructive Testing*

If concrete strength loss is suspected, destructive testing is the preferred approach to accurately quantify this effect. This typically involves coring cylinders from the affected members and performing standard compression tests. This can determine if the concrete meets the required strength capacity. The available locations for coring may be limited in prestressed members in regions with close strand and reinforcement spacing. For design, concrete strength is measured at the 28-day point in the curing process and it is well known that strength continues to increase with age. It is typical for tests performed on older age concrete to show strength exceeding f'c. Even with a slight reduction in capacity relative to the pre-fire strength, the concrete strength may still exceed the nominal design requirements. Refer to case study 2.

5. Post Fire Inspection Considerations

Steel members recover most of their strength when they cool following a fire event. This also applies to concrete reinforcing steel and prestressing strands. The compression strength of concrete does not recover following heating and may be slightly decreased below the high temperature strength. However, the relatively short duration of most bridge fires and the thermal properties of concrete usually results in minimal internal material damage for concrete members. The tension capacity of steel generally will have the most effect on strength, therefore structures can be expected to have higher strength after the fire than during the fire event. Structures that appear to have only minor deflections and damage will usually be safe to allow access for inspection. This does not necessarily apply to structures that have collision or other severe damage to concrete supporting or bearing elements.

5.1 *Composite Action*

Visual examination of the structure should be performed to detect any evidence of slip at the beam to deck interface. If such evidence exists, further evaluation may be specified by the District Bridge Engineer. Observation of behavior underneath the structure when live loads are on the bridge for evidence composite action slip. Sometimes movement, either vertical or horizontal can be detected as a truck crosses the bridge. If problems are still suspected, a field instrumentation study may be indicated. This can detect bridge stiffness and the effective neutral axis location for the composite girders. In general, there is probably no reason to perform such a study unless there is a strong indication of problems based on simple observations.

5.2 *Web Distortion*

AASHTO LRFD Bridge Design Specifications allows consideration of tension field action when evaluating shear strength and the capacity based on current codes may be greater than that calculated in the original design based on allowable stress design. This provides some relief when calculating the shear capacity of sections with web distortion. It is highly likely that large web distortions will be present following a severe fire event, particularly for welded plate girders. Analysis of large web distortions would require a 3D FEA of the girder. Thus, a practical solution is to add stiffeners instead of performing an advanced analysis.

Distortion of transverse stiffeners, cross frames, diaphragms, and other secondary members need to be assessed as required. It may be possible to ignore some deformation of transverse stiffeners if they are still capable of performing their web stiffening and connection functions. The welds near any such deformations need to be carefully inspected. Axial force members such as those used in cross frames or diaphragms often show effects of buckling or distortion following a severe fire event. The distortion typically occurs at peak heating when differential thermal expansion is at a maximum and the member strength is reduced. Some members may undergo a force reversal between the heating and cooling phases of a fire event. A member that is normally in tension may go into compression at high temperatures and revert back to tension when the structure cools.

5.3 *Bearings and Expansion Joints*

It is common to see bridges that have bearing damage and possible contact damage with abutment walls following fire events. The thermal expansion (longitudinal and transverse) can be much higher than anticipated by normal bridge temperature changes. Expansion at the bridge ends reflects the integration of the thermal expansion occurring at every section of the bridge. It is therefore possible to see bearing and joint problems away from the locations directly affected by the fire. Therefore, all expansion joints and bearings, regardless of location, require thorough inspection and evaluation following a significant fire event. Much of the bridge expansion present at peak temperature will recover as the bridge cools. Bearings may have suffered damage at the peak expansion point that may not be apparent after the bridge contracts. This is a particular concern for elastomeric or other non-mechanical bearing types.

Expansion joints require thorough inspection, again irrespective of their location relative to the fire. The large forces present at peak expansion may have caused compression damage to the joints and their attachment connections to the concrete. Bridges that experience any significant vertical deflection at high temperatures that recover as the bridge cools may cause tensile damage to the joints.

5.4 *Connections*

For strength evaluation, A325 and A490 structural bolts are heat-treated products that depend on controlled heating to obtain their properties during manufacturing. Lacking more precise information, it is recommended that bolts from any connections in primary members that may have experienced temperatures exceeding 200°C (392°F) should be tested. This can easily be done by removing a few bolts from the connection and testing them in a Skidmore device or in direct tension. Direct tension testing may be easier if the threads are distorted from the initial tensioning. If the bolts are found to have insufficient strength, it is relatively easy to replace the bolts incrementally to restore the connection capacity.

One factor that needs to be considered when evaluating primary connections at STRENGTH I is the 75% rule present in the AASHTO design specifications. Most girder splices built prior to the 9th Edition of the LRFD Bridge Design Specifications are located at locations with low moment in the girders. However, the connections are designed for at least 75% of the moment capacity of the member. The bolts in the connection may therefore have much higher shear strength than required for the actual loads. The engineer should consider this fact before replacing bolts if only a slight reduction in bolt strength is suspected.

It is a bit more difficult to determine the slip capacity for SERVICE II. Bolts are pretensioned to a large portion of their tension capacity during installation to provide frictional clamping force. Depending on the temperature and duration of the fire event, creep may be expected to allow relaxation of the initial bolt tension.

5.5 *Bridge Decks*

A detailed cracking survey should be performed following a significant fire event. Results should be interpreted using the same analysis that is used on non- fire exposed decks. Crack width can be evaluated concerning the expected effect on permeability. If concrete material changes are suspected, the permeability can be evaluated through destructive testing.

5.6 *Summary*

In summary of list of items to be inspected for steel girders, concrete girders and bridge decks as listed below.

Steel Girders:

Visual Inspection:
- Permanent deflection
- Paint condition
- Web distortion
- Welds – web to flange, stiffener and connection plate welds
- Bolts in bolted connections
- Bearings
- Joints

NDE and Testing:
- Specimen cores for mechanical properties including CVN
- Bolted connections – bolt removal for mechanical testing of high strength bolts

Concrete Girders:

Visual Inspection:
- Permanent deflection
- Spalling and delaminations
- Cracking
- Exposed reinforcing steel – mild and/or prestressing
- Bearings
- Joints

Testing:
- Concrete Cores for compression testing
- Rebound hammer
- Ultrasonic impact echo

Bridge Decks:

Visual Inspection:
- Cracking
- Spalling
- Delaminations
- Joints

Testing:
- Concrete core for compression testing
- Concrete core for permeability testing
- Rebound hammer
- Ultrasonic impact echo

6. Examples

Examples of test results for two bridges are presented to use as reference.

6.1 *Liberty Bridge Fire*

Through an experimental study by Lehigh University the fire temperature exceeded 1000^0C (1832°F). At this elevated temperature white deposits formed on the steel as illustrated below.

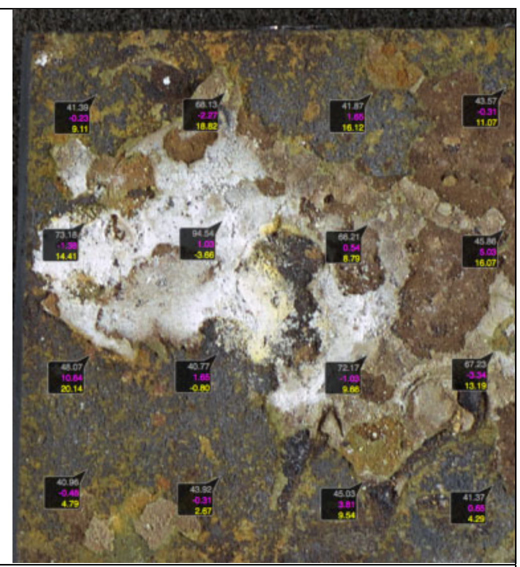
	
White Deposits on lacing	White deposit from experiment at 1000^0C (1832°F)

Figure 2 – Lacing member depicting white deposits.

Table 3 - Mechanical Property Testing Results of Samples from Liberty Bridge

SAMPLE ID	(ksi) TENSILE STRENGTH	(ksi) YIELD STRESS (0.2% OFFSET)	(%) ELONGATION IN 4D (MANUAL)	(%) REDUCTION OF AREA
DS Web West - 1	59.5	29.9	38	62
DS Web West - 2	60.5	30.5	38	60
DS Web West - 3	59.5	30.0	39	58
DS Web East - 1	57.0	29.2	41	66
DS Web East - 2	56.5	29.0	39	66
DS Web East - 3	58.0	28.4	39	63
US Web West - 1	58.5	28.8	39	62
US Web West - 2	58.5	29.3	39	60
US Web West - 3	58.5	28.3	41	63
US Web East - 1	60.0	28.4	38	62
US Web East - 2	60.0	28.8	38	63
US Web East - 3	60.5	28.5	39	63
Mid Web West - 1	65.5	30.9	34	56
Mid Web West - 2	64.0	31.0	34	59
Mid Web West - 3	66.0	30.8	28	40
Mid Web East - 1	56.0	29.2	42	65
Mid Web East - 2	56.5	29.6	42	68
Mid Web East - 3	56.0	28.2	41	64

Procedures/Methods: 86-TT-2, Rev. 15, Room Temp. Tensile Testing for Metallic Materials

Figure 3 – Location of 4-inch diameter Cores

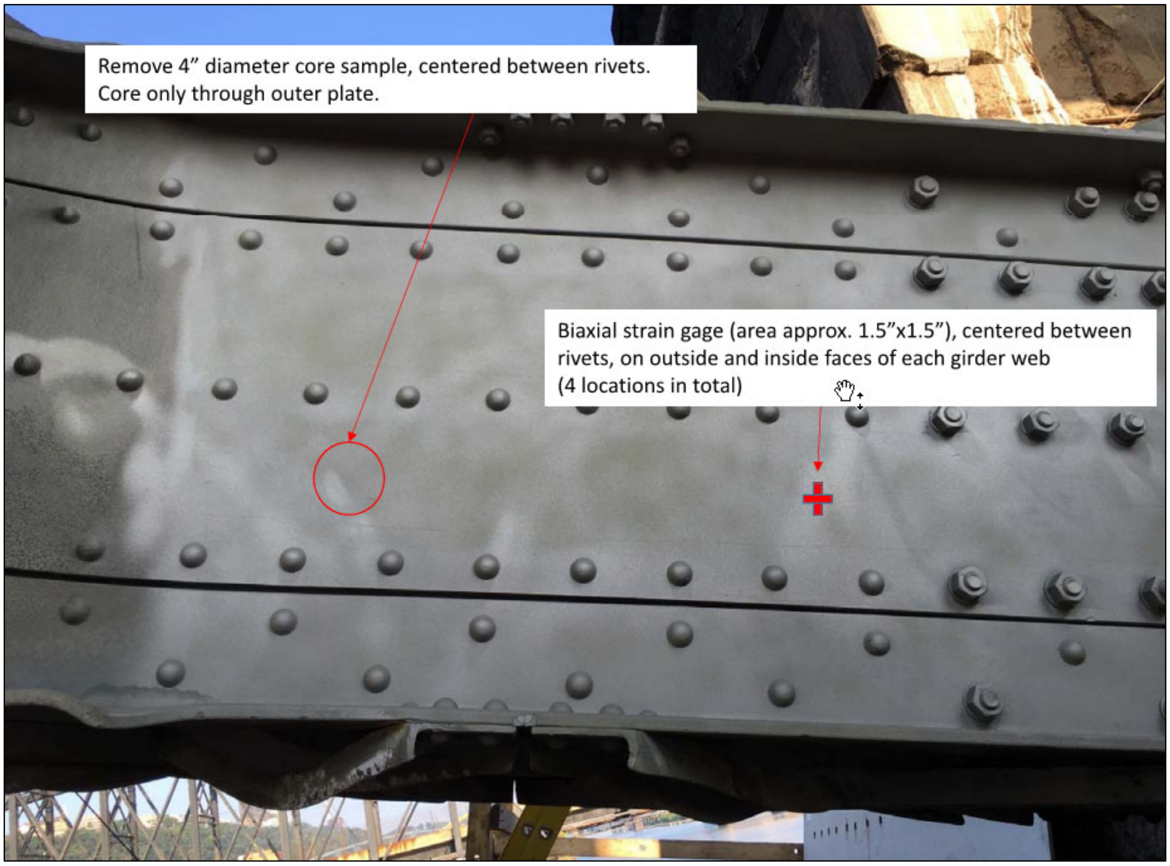


Figure 4 – Location of 4-inch diameter Cores

6.2 *Dauphin County SR 322*

The results of concrete and steel testing results and locations are presented below.

Concrete test results and locations:

Table 4 – Concrete Testing Results

May 2013: I-81 and Rt-22/322 Ramp Project -Diesel Tanker Damage							DCB - 5/19/13	
Core #	Arrival at Lab Date	Structure	Good/ Bad	Test	40 hr Date	40 hr Time	Strength PSI	Lab No.
1	5/16/2013	S-12184 Abutment Wing A Side Ramp B	Bad	Petro				13-48163-1
2	5/16/2013	S-12184 Abutment Wing A Side Ramp B	Bad	Comp. Str	18-May	6:30 AM	4310	13-48163-2
3	5/16/2013	S-12184 Abutment Wing A Side Ramp B	Bad	Comp. Str	18-May	6:30 AM	4800	13-48163-3
4	5/16/2013	S-12184 Wing A Side Backwall Ramp B	Good	Petro				13-48166-1
5	5/16/2013	S-12184 Abutment Wing B Side Ramp B	Good	Petro				13-48171-1
6	5/16/2013	S-12184 Abutment Wing B Side Ramp B	Good	Comp. Str	19-May	10:50 AM	4190	13-48171-2
7	5/16/2013	S-12184 Abutment Wing B Side Ramp B	Good	Comp. Str	19-May	10:50 AM	4460	13-48171-3
8	5/16/2013	S-12184 Wing B Side Backwall Ramp B	Good	Petro				13-48166-2
9	5/16/2013	S-12188 Flyover Pier #2 SR 22	Good	TBD - Small				13-48167-1
10	5/16/2013	S-12188 Flyover Pier #2 SR 22	Good	Comp. Str	19-May	10:30 AM	4800	13-48167-2
11	5/16/2013	S-12188 Flyover Pier #2 SR 22	Good	Petro				13-48167-3
12	5/16/2013	S-12188 Flyer Pier #2 SR 22	Good	TBD - Small				13-48167-4
13	5/16/2013	S-12188 Flyover Bridge - Pier Caps	Bad	Petro	Polished		5/17/2013	13-48165-1
14	5/16/2013	S-12188 Flyover Bridge - Pier Caps	Bad	Petro	Polished	Polished	5/17/2013	13-48165-2
15	5/16/2013	S-12188 Flyover Bridge - Pier Caps	Bad	Petro	Polished	Polished	5/17/2013	13-48165-3
16	5/16/2013	S-12188 Flyover Bridge - Pier Caps	Bad	Comp. Str	18-May	7:20 AM	3690	13-48165-4
17	5/16/2013	S-12188 Flyover Bridge - Pier Caps	Bad	Comp. Str	18-May	7:20 AM	4250	13-48165-5
18	5/16/2013	S-12184 Piers SR 22 Ramp B	Bad	Petro	Polished		5/17/2013	13-48168-1
19	5/16/2013	S-12184 Piers SR 22 Ramp B	Bad	Comp. Str	18-May	7:30 AM	5140	13-48168-2
20	5/16/2013	S-12184 Piers SR 22 Ramp B	Bad	Comp. Str	18-May	7:30 AM	5750	13-48168-3
21	5/16/2013	S-12184 Pier #1 Pier Caps Ramp B	Bad	Petro	Polished		5/17/2013	13-48169-1
22	5/16/2013	S-12184 Pier #1 Pier Caps Ramp B	Bad	Comp. Str	18-May	7:30 AM	4380	13-48169-2
23A	5/16/2013	S-12184 Pier #1 Pier Caps Ramp B	Bad	Comp. Str	18-May	7:30 AM	4970	13-48169-3A
23B	5/16/2013	S-12184 Pier #1 Pier Caps Ramp B	Bad	Comp. Str	18-May	7:30 AM	4610	13-48169-3B
24	5/16/2013	S-12184 Pier #1 Pier Caps Ramp B	Bad	Comp. Str	18-May	7:30 AM	5020	13-48169-4
25	5/16/2013	S-12184 Pier Caps Pier #1	Good	Petro				13-48170-1
26	5/16/2013	S-12184 Pier Caps Pier #1	Good	Comp. Str	19-May	11:00 AM	4040	13-48170-2
27	5/16/2013	S-12184 Pier Caps Pier #1	Good	Comp. Str	19-May	11:00 AM	4190	13-48170-3
28	5/17/2013	S-12184 Pier Ramp B	Good	Comp. Str	19-May	11:05 AM	5620	13-48172-1
29	5/17/2013	S-12184 Pier Ramp B	Good	Petro				13-48172-2
30	5/17/2013	S-12184 Pier Ramp B	Good	Comp. Str	19-May	11:05 AM	5040	13-48172-3
31	5/17/2013	S-12188 Flyover Pier #1 Pier Cap	Bad	Petro				13-48173-1
32	5/17/2013	S-12188 Flyover Pier #1 Pier Cap	Bad	TBD - Small				13-48173-2
33	5/17/2013	S-12188 Flyover Pier #1 Pier Cap	Bad	TBD - Small				13-48173-3
34	5/17/2013	S-12188 Flyover Pier #1 Pier Cap	Bad	Comp. Str	19-May	11:05 AM	4780	13-48173-4
35	5/17/2013	S-12188 Flyover Pier #1 Pier Cap	Bad	Comp. Str	19-May	11:05 AM	4440	13-48173-5
36	5/17/2013	S-12188 Flyover Pier #1	Good	Petro				13-48174-1
37	5/17/2013	S-12188 Flyover Pier #1	Good	Comp. Str	19-May	11:05 AM	4250	13-48174-2
38	5/17/2013	S-12188 Flyover Pier #1	Good	Comp. Str	19-May	11:05 AM	3860	13-48174-3

Table 5 – Summary Results at various substructure locations

Ramp B	Range of Compressive Strengths (psi)		Avg. Compressive Strength (psi)	
	Good Areas	Bad Areas	Good Areas	Bad Areas
Pier Caps	4040-4190	4380-5020	4115	4745
Piers	5040-5620	5140-5750	5330	5445
Abutment	4190-4460	4310-4800	4325	4555

Figure 5 – Location of Concrete Cores

Steel test results and locations:

Table 6 – Steel Mechanical Property Results

I-81 Ramp B Steel Test Results

ID#	Thickness	CVN (avg) NFC Zone 2		Yield ksi (lowest)		Tensile ksi (lowest)		Elongation % (lowest)	
		primary	verification	primary	verification	primary	verification	primary	verification
		PRL	*PennDOT*	PRL	*PennDOT*	PRL	*PennDOT*	PRL	*PennDOT*
A36		15ft-lbs@40°F		36 ksi min		58-80 ksi		23% min	
G1-2-BF-1	1½"	93.0	*90.7*	43.9	*37.9*	70.0	*70.7*	33.6	*34*
G1-2-W-1	⅜"	54.7	*72.7*	40.0	*37.9*	70.1	*72.4*	35.9	*47*
G2-2-BF-1	1½"	61.7	*68.3*	35.5	*	70.3	*70.6*	33.6	*33*
G5-2-W-1	⅜"	61.0	*65.2*	44.9	*44.2* #	76.0	*74.5*	40.6	*34*
G5-2-W-2	⅜"	53.0	*54.6*	42.9	*44.2*	77.3	*79.3*	39.1	*36*
G5-2-BF-1	2¼"	62.0	*68.4*	37.3	*37.7*	69.6	*70.4*	35.2	*36*
A572	Lab Testing			50 ksi min		65 ksi min		21% min	
G3-2-TF-1	1½"	46.0	*39.6*	52.5	*54.0*	83.0	*85.0*	27.0	*26*
G4-2-W-1	⅜"	39.0	*44.6*	54.5	*54.9*	77.0	*78.4*	32.0	*31*
A588		20ft-lbs@40°F>2" thickness		50 ksi min		70 ksi min		21% min	
G4-2-TF-1	2¼"	119.0	*162.5*	47.3	*46.9*	74.0	*74.9*	30.0	*29*
G4-2-BF-1	1⅞"	99.0	*93.0*	51.0	*52.0*	78.5	*79.7*	29.0	*28*

* invalid yield due to test grip/specimen incompatibility

\# one of the initial 2 samples had a low yield at 32.2 ksi, so PennDOT prepared and tested 2 additional samples which both had yield results greater than 36 ksi and is considering the 32.2 ksi as an outlier due to the preparation and subsequent compromise in testing.

Figure 6 – Location of steel coupon

APPENDIX IP 02-H

Fatigue & Fracture Plan

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pennsylvania
DEPARTMENT OF TRANSPORTATION

Fatigue and Fracture (F&F) Plan

Structure ID (5A01): ____________________ **BRKEY (5A03):** __________
Structure Name: ____________________ **Original F&F Plan Date:** __________
District: __________ **Reviewed/Updated:** __________

Note: This F&F plan is in accordance with PennDOT Pub 238, IP 2.4.5.1. This plan shall be reviewed and updated if needed during each Routine inspection. A copy of the latest version of the F&F Plan shall be uploaded to Inventory documents in BMS2.

1. Bridge Condition:

Deck (1A01) = __________ Sub (1A02) = __________
Super (1A04) = __________ Posting = __________

Notes:

2. FC Inspection Scope and Frequency:

Note: Indicate the portions of the superstructure that require a require a hands-on FC Inspection and the interval required for the inspection.

Routine Inspection:

Interim Inspection:

3. Access Equipment and Special Testing Needs:

Note: List any access equipment necessary to complete the FC inspection. Also, list any special testing equipment required in addition to the standard magnifying glass, dye penetrant, and lighting for a FC inspection (i.e. ultrasonic testing equipment for testing of pins).

Routine Inspection:

Interim Inspection:

4. Approval

Note: Approval is required only when the Interim inspection is a limited inspection (Does not include all FCM) or a less than full hands on Routine inspection of the FCM members is proposed for concrete encased FCMs.

The proposed Limited scope Interim F&F plan is satisfactory to meet FC inspection requirements.

District Bridge Engineer ____________________ __________
Signature Date

The proposed less than full hands-on FC Routine inspection of the concrete encased FCMs is satisfactory to meet FC inspection requirements.

District Bridge Engineer ____________________ __________
Signature Date

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APPENDIX IP 03-A

PA Bridge Posting Vehicles
Table of Live Load Effects on Simple Spans
(No Impact Included)

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Publication 238 (2021 Edition), Appendix IP 03-A
PA Bridge Posting Vehicles Table of Live Load Effects on Simple Spans
(No Impact Included)

SPAN	LIVE LOAD MOMENT Ft.-Kips per Wheel Line				LIVE LOAD SHEAR Kips per Wheel Line			
	NON-COMBINATION VEHICLE			COMBINATION	NON-COMBINATION VEHICLE			COMBINATION
Feet c/c	H20	ML-80 (1)	TK-527 (1)	HS20	H20	ML-80 (1)	TK-527 (1)	HS20
8	32.0	23.2	23.2	32.0	16.0	15.5	15.5	16.0
9	36.0	27.8	27.8	36.0	16.0	17.2	16.5	16.0
10	40.0	36.0	33.0	40.0	16.0	18.5	17.3	16.0
11	44.0	43.4	40.0	44.0	16.0	19.7	18.0	16.0
12	48.0	51.5	45.3	48.0	16.0	20.6	18.5	16.0
13	52.0	59.0	52.3	52.0	16.0	21.4	19.3	16.0
14	56.0	67.0	57.7	56.0	16.0	22.1	20.0	16.0
15	60.0	74.5	64.6	60.0	16.3	22.7	20.6	17.1
16	64.0	82.4	70.0	64.0	16.5	23.2	21.1	18.0
17	68.0	90.0	77.3	68.0	16.7	23.6	21.8	18.8
18	72.0	97.8	84.5	72.0	16.9	24.0	22.4	19.6
19	76.0	105.5	91.7	76.0	17.1	24.8	23.0	20.2
20	80.0	113.3	98.9	80.0	17.2	25.4	23.5	20.8
21	84.0	121.0	106.2	84.0	17.3	26.0	24.1	21.3
22	88.0	128.7	113.3	88.0	17.5	26.5	24.7	21.8
23	92.0	136.4	120.6	92.0	17.6	27.0	25.3	22.3
24	96.0	144.7	129.2	96.3	17.7	27.5	25.8	22.7
25	100.0	151.6	136.8	103.7	17.8	27.9	26.2	23.0
26	104.0	160.1	145.5	111.1	17.8	28.3	26.6	23.4
27	108.5	167.8	153.2	118.5	17.9	28.6	27.0	23.7
28	113.4	177.5	161.9	126.0	18.0	28.9	27.4	24.0
29	118.4	186.5	169.6	133.5	18.1	29.2	27.7	24.4
30	123.3	196.1	178.6	141.0	18.1	29.5	28.0	24.8
31	128.3	205.3	187.6	148.6	18.2	29.8	28.3	25.2
32	133.2	214.9	197.0	156.2	18.3	30.0	28.6	25.5
33	138.2	224.0	206.0	163.9	18.3	30.3	28.8	25.8
34	143.2	233.6	215.2	171.8	18.4	30.5	29.1	26.1
35	148.1	242.9	224.5	180.6	18.4	30.7	29.4	26.4
36	153.1	252.3	233.6	189.4	18.4	30.9	29.8	26.7
37	158.1	261.8	242.7	198.3	18.5	31.1	30.1	26.9
38	163.0	271.1	251.8	207.1	18.5	31.2	30.4	27.2
39	168.0	280.4	261.2	216.0	18.6	31.4	30.6	27.4
40	173.0	289.9	270.3	224.9	18.6	31.6	30.9	27.6
42	182.9	308.7	288.8	242.7	18.7	31.9	31.4	28.0
44	192.9	327.6	307.3	260.4	18.7	32.1	31.8	28.4
46	202.9	346.4	325.6	278.3	18.8	32.4	32.2	28.7
48	212.8	365.1	344.0	296.1	18.8	32.6	32.6	29.0
50	222.8	384.0	362.7	314.0	18.9	32.8	33.0	29.3
52	232.8	402.8	380.9	331.8	18.9	33.0	33.3	29.5
54	242.7	421.7	399.7	349.7	19.0	33.2	33.6	29.8
56	252.7	440.8	418.7	367.6	19.0	33.3	33.8	30.0
58	265.1*	459.4	438.9	385.4	19.0	33.5	34.1	30.2
60	279.0*	478.3	459.3	403.3	19.1	33.6	34.3	30.4

PA Bridge Posting Vehicles Table of Live Load Effects on Simple Spans
(No Impact Included)

SPAN	LIVE LOAD MOMENT Ft.-Kips per Wheel Line				LIVE LOAD SHEAR Kips per Wheel Line			
	NON-COMBINATION VEHICLE			COMBINATION	NON-COMBINATION VEHICLE			COMBINATION
Feet c/c	H20	ML-80 (1)	TK-527 (1)	HS20	H20	ML-80 (1)	TK-527 (1)	HS20
62	293.3*	497.0	479.7	421.2	19.1	33.8	34.6	30.6
64	307.8*	515.9	500.1	439.1	19.1	33.9	34.8	30.8
66	322.7*	534.7	520.5	457.0	19.2	34.0	35.0	30.9
68	338.0*	553.7	540.9	474.9	19.2	34.1	35.1	31.1
70	353.5*	572.1	561.8	492.8	19.2	34.2	35.3	31.2
72	369.4*	591.4	582.2	510.7	19.2	34.3	35.5	31.3
74	385.5*	610.1	602.7	528.6	19.2	34.4	35.6	31.5
76	402.0*	629.1	623.1	546.6	19.3	34.5	35.8	31.6
78	418.9*	648.1	643.5	564.5	19.3	34.6	35.9	31.7
80	436.0*	666.8	663.9	582.4	19.3	34.7	36.1	31.8
85	480.3*	713.9	715.1	627.3	20.1*	34.8	36.4	32.0
90	526.5*	760.9	766.3	672.2	20.9*	35.0	36.6	32.3
95	574.8*	808.1	817.5	717.1	21.7*	35.1	36.9	32.5
100	625.0*	854.9	868.6	762.0	22.5*	35.3	37.1	32.6
105	677.3*	902.1	919.8	806.9	23.3*	35.4	37.3	32.8
110	731.5*	949.7	971.9	851.8	24.1*	35.5	37.5	32.9
115	787.8*	996.2	1023.1	896.7	24.9*	35.6	37.6	33.1
120	846.0*	1044.3	1074.4	941.6	25.7*	35.7	37.8	33.2
125	906.3*	1091.1	1125.7	986.6	26.5*	35.8	37.9	33.3
130	968.5*	1137.8	1177.0	1031.5	27.3*	35.8	38.0	33.4
135	1032.8*	1185.2	1228.2	1076.5	28.1*	35.9	38.1	33.5
140	1099.0*	1232.4	1279.5	1121.4	28.9*	36.0	38.3	33.6
145	1167.3*	1279.3	1330.7	1167.3*	29.7*	36.0	38.4	33.7
150	1237.5*	1326.6	1382.3	1237.5*	30.5*	36.1	38.5	33.8
155	1309.8*	1373.9	1434.2	1309.8*	31.3*	36.1	38.5	33.8
160	1384.0*	1421.4	1485.0	1384.0*	32.1*	36.2	38.6	67.8
165	1460.3*	1469.0	1536.2	1460.3*	32.9*	36.2	38.7	34.0
170	1538.5*	1515.4	1587.7	1538.5*	33.7*	36.3	38.8	34.0
175	1618.8*	1562.1	1639.8	1618.8*	34.5*	36.3	38.8	34.5*
180	1701.0*	1609.1	1690.8	1701.0*	35.3*	36.4	38.9	35.3*
185	1785.3*	1656.7	1742.4	1785.3*	36.1*	36.4	39.0	36.1*
190	1871.5*	1704.9	1794.8	1871.5*	36.9*	36.4	39.0	36.9*
195	1959.8*	1752.0	1846.1	1959.8*	37.7*	36.5	39.1	37.7*
200	2050.0*	1797.9	1896.3	2050.0*	38.5*	36.5	39.1	38.5*
205	2142.3*	1846.6	1949.4	2142.3*	39.3*	36.5	39.2	39.3*
210	2236.5*	1892.1	1999.4	2236.5*	40.1*	36.6	39.2	40.1*
215	2332.8*	1940.8	2050.5	2332.8*	40.9*	36.6	39.3	40.9*
220	2431.0*	1988.6	2102.8	2431.0*	41.7*	36.6	39.3	41.7*
225	2531.3*	2035.1	2154.1	2531.3*	42.5*	36.6	39.4	42.5*
230	2633.5*	2080.5	2206.9	2633.5*	43.3*	36.7	39.4	43.3*
235	2737.8*	2130.0	2255.9	2737.8*	44.1*	36.7	39.4	44.1*
240	2844.0*	2175.7	2309.3	2844.0*	44.9*	36.7	39.5	44.9*
245	2952.3*	2223.0	2358.8	2952.3*	45.7*	36.7	39.5	45.7*
250	3062.5*	2269.3	2410.2	3062.5*	46.5*	36.8	39.6	46.5*

Publication 238 (2021 Edition), Appendix IP 03-A
PA Bridge Posting Vehicles Table of Live Load Effects on Simple Spans
(No Impact Included)

	LIVE LOAD MOMENT Ft.-Kips per Wheel Line				LIVE LOAD SHEAR Kips per Wheel Line			
SPAN	NON-COMBINATION VEHICLE			COMBINATION	NON-COMBINATION VEHICLE			COMBINATION
Feet c/c	H20	ML-80 (1)	TK-527 (1)	HS20	H20	ML-80 (1)	TK-527 (1)	HS20
255	3174.8*	2317.6	2463.6	3174.8*	47.3*	36.8	39.6	47.3*
260	3289.0*	2364.8	2516.1	3289.0*	48.1*	36.8	39.6	48.1*
265	3405.3*	2411.4	2566.1	3405.3*	48.9*	36.8	39.6	48.9*
270	3523.5*	2458.6	2617.6	3523.5*	49.7*	36.8	39.7	49.7*
275	3643.8*	2505.8	2669.0	3643.8*	50.5*	36.8	39.7	50.5*
280	3766.0*	2552.9	2720.5	3766.0*	51.3*	36.9	39.7	51.3*
285	3890.3*	2600.1	2772.0	3890.3*	52.1*	36.9	39.8	52.1*
290	4016.5*	2647.3	2823.5	4016.5*	52.9*	36.9	39.8	52.9*
295	4144.8*	2694.5	2875.0	4144.8*	53.7*	36.9	39.8	53.7*
300	4275.0*	2741.6	2926.4	4275.0*	54.5*	36.9	39.8	54.5*

*Based on standard lane loading. All other values based on standard truck loading
(1) Includes 3% scale tolerance (See IP 3.2.2.2) for non-notional vehicles

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APPENDIX IP 03-B

Guidelines for Live Load Rating of Selected Concrete Bridges Without Plans Using Engineering Judgement

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Publication 238 (2021 Edition), Appendix IP 03-B
Guidelines for Live Load Rating of Selected Concrete Bridges
Without Plans Using Engineering Judgement

Description:

The following is a guideline for using engineering judgment to determine the live load rating capacity of selected concrete bridges where the structural components of the main load carrying members are not known with sufficient confidence to use an analytical approach for the rating. These bridges are frequently known as "concrete bridges without plans". These guidelines follow the approach outlined in Publication 238, IP 3.6.1.1.

Disclaimer:

This guideline does not relieve the rating engineer of their responsibility of determining the applicability of the bridge to this methodology, of properly assessing the condition of the bridge and its behavior under live load, and/or of verifying the accuracy of the resulting ratings.

Applicability of Guidelines:

- The structural components of the main load carrying members are not known sufficiently to use an analytical approach to determine the live load ratings
- The condition of the main load carrying members is known and rated using the Condition Rating as set forth in BMS2 Coding Manual, Publication 100A
- The behavior of the bridge under vehicular live load is known by visual observation
- This method is limited to the following types of non-Fracture Critical superstructures
    - Reinforced Concrete Slab
    - Reinforced Concrete T-Beam
    - Prestressed/Pretensioned Concrete Beams (Not permitted for Adjacent Non-Composite Prestressed Concrete Box Beams)
- The method is limited to simple span structures with lengths from 8' to 50' and for all skews
- The inspection frequency specified in Table A of these guidelines will not be exceeded
- Based on engineering judgment, SLC values greater than those given in Table A may be used, however the value shall be no greater than the Operating Rating.

Assumptions:

1. The critical legal load for the range of applicability is the ML80 vehicle
2. Moment controls the live load rating
3. Safe Load Capacity = 100% of Operating Rating, except for members in poor, critical, or serious condition
   When following the procedure below, a reduction factor is already incorporated into Table A for bridges with a superstructure and/or substructure condition rating of 4 or less. The Safe Load Capacity Reduction Factor should not be applied as shown in Publication 238, IP 3.6.1.1.
4. Inventory Rating = 60% of Operating Rating

Procedure:

1. Determine the condition rating for the critical main load-carrying member of the bridge from a bridge safety inspection performed in accordance with Publication 238.

2. Determine the distress level of the bridge superstructure under vehicular live load using Table B of these guidelines.
   NOTE: Member condition ratings of 5 through 9 should not see distress under live load. If distress is observed, the member condition rating should be no higher than a 4.

3. Determine the ML80 truck live load ratings (IR_{ML80}-Inventory Rating, OR_{ML80}-Operating Rating, SLC_{ML80}- Safe Load Capacity) from Table A of these guidelines, using the following:
   A. Condition rating of main load carrying member
   B. Distress level of bridge superstructure
   C. ADTT (Average Daily Truck Traffic) on the bridge

4. Determine the live loadings for the other Bridge Posting Vehicles (H, HS, TK527) based on a comparison of their live load bending moments to the ML80 bending moment for the bridge's span length.

A. Determine the Rating Factor for ML80 Safe Load Capacity Rating Factor for SLC_{ML80} = (SLC_{ML80} / W_{ML80})

Where: SLC_{ML80} is from Table A

B. *W_{ML80} = ML80 Gross Vehicle Weight = 36.64 T* Determine the Rating Factor for each of the Bridge Posting Vehicles at SLC using the ratio of live load moments. Using HS as an example:

Rating Factor for SLC_{HS} = (Rating Factor for SLC_{ML80}) * (LLM_{ML80} / LLM_{HS})

Where: LLM = Live Load Moment for each vehicle
LLM values from App IP-03A may be used here

C. Determine the SLC (in Tons) for each of the Bridge Posting Vehicles. Again, using HS as the example:

SLC_{HS} = (Rating Factor for SLC_{HS}) * (W_{HS})

Where: W_{HS} = HS Gross Vehicle Weight = 36.0 Tons

D. Determine the Operating Rating and Inventory Rating for each of the Bridge Posting Vehicles. Continuing with the HS example:

OR_{HS} = SLC_{HS} * (OR_{ML80}/SLC_{ML80}) IR_{HS} = 60% * OR_{HS}

E. Repeat Steps 4B through 4D for H and TK527 vehicles

5. The rating engineer is to review the ratings developed using this method to determine if the results are acceptable based on the rater's knowledge of the bridge and other traffic and site conditions. The maximum inspection frequency specified in Table A must be complied with in following inspections or this method is not considered valid. The rating engineer is to place their signature and affix their PE stamp to the rating documentation.

6. The Documentation Form (Page 5 of 6) is actable documentation for a live load rating developed using these guidelines.

7. The rating engineer develops a post evaluation and recommendation based upon live load capacities determined in Steps 1-5. The posted bridge weight restriction is not to exceed the SLC.

TABLE A: ML80 Live Load Ratings for Selected Concrete Bridges without Plans

Controlling Member		**ML80 Ratings (Tons)**				**Maximum Inspection Interval**
Condition Rating	**Distress Level**	**Safe Load Capacity**		**Operating Rating**	**Inventory Rating**	
9 Excellent	N/A	65		65	39	24
8 Very Good	N/A	65		65	39	24
7 Good	N/A	65		65	39	24
6 Satisfactory	N/A	60		60	36	24
5 Fair	N/A	60		60	36	24
4 Poor	1	*ADTT ≥500*	36	45	27	12 [1]
		ADTT <500	40			
	2	*ADTT ≥500*	30	40	24	12 [1]
		ADTT <500	36			
3 Serious	1	*ADTT ≥500*	30	40	24	12
		ADTT <500	32			
	2	*ADTT ≥500*	18	25	15	12
		ADTT <500	20			
	3	12		20	12	12
2 Critical	2	6		10	6	6
	3	3		5	3	6
1	N/A	Closed		0	0	24 [2]

NOTES:
N/A Not Applicable
[1] Maximum interval applies when the bridge is posted for weight restriction only. Otherwise see Pub 238, Table IP 2.3.2.4-1, for inspection interval.
[2] Requires Closed Bridge inspection only

TABLE B: Distress Level for selected concrete bridges without plans

DISTRESS LEVEL		GENERAL DESCRIPTION OF DISTRESS	SPECIFIC DESCRIPTION
Prestressed Concrete Superstructure	Reinforced Concrete Superstructure		
1	1	GOOD	No signs of Live Load induced distress due to vehicular traffic
1	2	FAIR	Hairline flexure cracks visible
2	3	FAIR	Working flexure cracks with movement visible under vehicular loads – Or, loss of anchorage for mild reinforcement
3	3	POOR	Working shear cracks or working flexure cracks with visible deflection under vehicular loads – Or, Loss of anchorage for P/S strand

Live Load Rating Documentation Form

County: ______________________ **S.R. ID.** ______________________

Feature Carried: ______________________ **Over:** ______________________

Bridge Type: ____

Span Length: ______________________ **ADTT:** ______________

Controlling Member: ____

Condition: ____

____

____

Distress Level: ______________________ **Date of Inspection:** ______________

Bridge Posting Vehicle	Live Load Moment	SLC Rating Factor	W (Tons)	Ratings in Tons			Comments
				SLC	OR	IR	
ML80							From Table A
			36.64				Calculated
H			20.00				Calculated
TK527			40.00				Calculated
HS			36.00				Calculated

BMS2 DATA	Vehicle Configurations						
	H	HS	ML80	4	5	LF	TK527
IR10 IR	1 ______	2 ______	8 ______	________	________	NNN	0______
IR11 OR	1 ______	2 ______	8 ______	________	________	NNN	0______

IR06 = 7 - Engineering Judgement

Prepared By: ______________________________ **Date:** ______________
Rating Engineer

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APPENDIX IP 03-C

Load Rating Summary Form

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LOAD RATING SUMMARY FORM

Done By: ___________ **Date:** ___________

Checked By: ___________ **Date:** ___________

Structure ID (5A01): ________________________ **Inspection Date (7A01):** ___________

Facility Carried (5A08): ______________________________

Feature Intersected (5A07): ______________________________

Structure Type (6A26 - 6A29): ______________________________

Spans / Members Analyzed: ______________________________

Analysis Method: ______________________________

PennDOT Program / Version: ______________________________

VEHICLE	IR (Factor / TONS)	OR (Factor / TONS)	CONTROLLING MEMBER / SPAN		LOAD EFFECT (M/V)	
			IR	OR	IR	OR
H20						
HS20						
ML80						
TK527						
PHL-93						

Comments/Assumptions*: ______________________________

* Identify the amount of section loss and section remaining analyzed, for the member and location that controls, wearing surface thickness used in analysis, and other significant information. These comments should also be recorded in BMS2 item IR19.

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APPENDIX IP 03-D

Assigned Load Rating Approval

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pennsylvania
DEPARTMENT OF TRANSPORTATION

ASSIGNED LOAD RATING APPROVAL

Structure ID (5A01): ____________________ **BRKEY (5A03):** ____________________

Facility Carried (5A08): ____________________

Feature Intersected (5A07): ____________________

The following conditions, described in Sec. IP 3.5.1.2, must be met to assign the load rating from the design plans/calculations:

1. The bridge was designed and checked using either the AASHTO Load and Resistance Factor Design (LRFD) or Load Factor Design (LFD) methods to at least PHL-93 or HS-20 live loads, respectively.

   ______ True ______ False

2. The bridge was built in accordance with the design plans or shop drawings.

   ______ True ______ False

   Design Drawing Number:

3. No changes to the loading conditions or the structure condition have occurred that could reduce the inventory rating below the design load level.

   ______ True ______ False

4. An evaluation has been completed and documented, determining that the force effects from State legal loads or permit loads do not exceed those from the design load (Note: This will be true for all bridges designed by PennDOT standards for the PHL-93 vehicle).

   ______ True ______ False

5. The checked design calculations, and relevant computer input and output information, are accessible and referenced or included in the individual bridge records.

   ______ True ______ False

Note: If complete design files have not been retained for existing bridges, design plans that clearly identify the loading as at least PHL-93 or HS-20 and bear the stamp of a licensed professional engineer may be used by the individual responsible for load rating under 23 CFR 650.309(c) as the basis for an assigned load rating. The approval needs to be documented as the basis for the assigned rating and become part of the official bridge records. This information demonstrates satisfaction of conditions (1) and (5) above. Conditions (2), (3), and (4) still need to be met.

This bridge meets the above mentioned criterion (all marked "True") and qualifies for an assigned load rating.

Signed: ____________________

Name: ____________________

Title ADBE-I *

Date: ____________________

** Assistant District Bridge Engineer-Inspection or an individual meeting 23 CFR 650.309© and delegated, in writing, this approval authority.*

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APPENDIX IP 04-A

Bridge Load Posting
Recommendation Form

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pennsylvania
DEPARTMENT OF TRANSPORTATION
www.penndot.gov

BRIDGE LOAD POSTING RECOMMENDATION FORM

BMS ID	BRKEY	COUNTY	ROUTE SR / T-	SEG	OFFSET	DETOUR LENGTH (Miles)	MUNICIPALITY
Bridge Name:							
Feature Carried:						School Bus Route:	
Feature Intersected:						Public Transp Route:	
ADT:	ADTT%:		NHS:			PUC Jurisdiction:	

PREVIOUS BRIDGE POSTING:		Year last posted:
Weight Limit: tons	Except Combinations: tons	☐ One Truck at a Time

RECOMMENDED POSTING UNDER § 4902(A) OF THE PA VEHICLE CODE:		
Weight Limit: tons	Except Combinations: tons	☐ One Truck at a Time:
Bridge Closed:	Closed but Open for Pedestrian Access Only:	
Posting Based On:	☐ Structural Analysis AND/OR	☐ Structural Condition
Controlling Member(s):		
Reason (as per Pub 238, Sec IP 4.3.1.1)		

STRUCTURE DATA:		
Structure Type:	Main: Approach:	
Number of Spans	Structure Length: ft.	Depth of Fill: ft. *(if applicable)*
Bridge Roadway Width ft.	No. Traffic Lanes:	Sidewalk Width *(ft)*: Lt. Rt.
Year Built:	Year Last Reconstructed/Rehab:	Reconstruction Type:

BRIDGE CONDITION RATINGS:			
Date of Last Inspection:			
Deck	Superstructure	Substructure	Culvert
Deck Geometry Appraisal:		Approach Alignment Appraisal:	
Comments:			

BRIDGE RATING ANALYSIS:

Controlling Member(s): | Controlling Span(s):

☐ Non-Redundant | ☐ Fatigue Sensitive | ☐ Interior/Fascia Girder *(if multi-girder)*

Inventory Ratings:	Full Lanes:	H tons	HS tons	ML-80 tons	TK527 tons
	One Truck:	H tons	HS tons	ML-80 tons	TK527 tons
Operating Ratings:	Full Lanes:	H tons	HS tons	ML-80 tons	TK527 tons
	One Truck:	H tons	HS tons	ML-80 tons	TK527 tons
SLC Ratings:	Full Lanes:	H tons	HS tons	ML-80 tons	TK527 tons
	One Truck:	H tons	HS tons	ML-80 tons	TK527 tons

Analysis Method:
- ☐ AASHTO Line Girder with Simplified (S-Over) LL Distribution Factors
- ☐ AASHTO Line Girder with NCHRP LL Distribution Factors
- ☐ 2D/Grillage ( )
- ☐ 3D/FEM ( )
- ☐ PDT Box Culvert Analysis Program
- ☐ Other ( )

Rating Method:
- ☐ Working Stress
- ☐ Load Factor
- ☐ Load & Resistance Factor
- ☐ Engineering Judgment
- ☐ Other ( )

Special assumptions used for analysis:

Controlling member conditions: (i.e., % deterioration, location of deterioration, etc.)

Are traffic conditions for 'One Truck at a Time' restriction valid according to Pub. 238?
(If 'YES', District Traffic Engineer must approve -- see Page 3 of 3)

PROGRAMMING DATA:

MPMS #: | Programming Status: ☐ No Work Programmed ☐ Contract ☐ Dept Force ☐ On TIP ☐ Twelve Year Program (TYP) - four-year period

Scope of Work: ☐ Replace ☐ Rehab ☐ Repair | Estimated Let Date:

Costs ($000): PE - $ FD - $ UTL/ROW - $ Construction - $

ECONOMIC IMPACT OF RECOMMENDED POSTING:	
Will recommended posting adversely impact Industry/Business?	
If yes, provide brief discussion:	

IMPACT OF RECOMMENDED POSTING ON HAULERS ON POSTED AND BONDED ROADWAYS:	
Is the roadway posted, if so what is the weight limit?	Tons
Are there any hauling permits already approved that will use this route?	
If yes to any question, provide brief description including a potential alternate route or posted bridge permits.:	

IMPACT OF RECOMMENDED POSTING ON EMERGENCY SERVICES, ETC.	
Provide a brief description of the impact on each public service (i.e., permit required, detour required) and explain how each service will be accommodated especially for low load-level postings. Average weights are provided below; however, each owner should verify actual weights of vehicles utilizing the bridge.	
Winter services or other maintenance: *(Average loaded weight of 28 Tons for a Plow Truck)*	
Ambulance: *(Average weight of 6 Tons)*	
Fire Truck: *(Average weight of 19 to 30 Tons)*	
School Bus and/or Public Transportation: *(Average loaded weight: School Bus 17 Tons Charter Bus 20 Tons)*	

NOTIFICATION TO THE PUBLIC:	
If the restriction on the route will cause significant traffic implications, provide description of how the public will be notified (e.g., Press Release).	

The bridge posting recommendation has been developed and accepted and is accurate to the best of my knowledge.

APPROVALS	Signature	Date
District Bridge Engineer *(Only required for PennDOT owned bridges)*		
District Traffic Engineer *(Only if posted "Bridge Limited to One Truck")*		
Local Owner Engineer *(Only for locally owned bridges. Approval must be by a Professional engineer working for the owner or their consultant)*		

APPENDIX IP 04-B

Posting Authorization Request Letter

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pennsylvania
DEPARTMENT OF TRANSPORTATION

DATE: **XX-XX-XX**

SUBJECT: Posting Authorization Request Letter
BMS No. **XX-XXXX-XXXX-XXXX**
SR **XXXX** over **[FEATURE INTERSECTED]**
[TOWNSHIP], [COUNTY]

TO: **[NAME]**, District Executive
District **X-**0

FROM: **[NAME]**, District Bridge Engineer

Based on **a load rating analysis of current conditions**, the subject bridge requires a weight limit posting of **XX Tons / Except Combinations XX Tons**. The bridge is to be restricted under §4902(a) of the PA Vehicle Code. The bridge is currently **not restricted**. This posting is due **to the main bridge members are deficient and cannot carry legal loads safely.** The most recent inspection date is **[MONTH] XX, XXXX.** The Bridge Load Posting Recommendation Form, Load Rating Summary Form, and **a diagram of standard vehicles and weights (optional)** are attached for your reference.

Based on the weight restriction, Emergency Vehicles will **not be affected.** Also, based on the weight restriction, Haulers will **not need to be re-routed.** Currently, one Permits is approved to use this route. The weight restriction will **have minimal effect on the traveling public; therefore, there is no planned public communication.**

Your signature below will provide approval of the proposed weight limit restriction.

____
[NAME]
District Executive, District **X-0**

Encl: Bridge Load Posting Recommendation Form
Load Rating Summary Form
Diagram of Standard Vehicles and Weights (optional)
Site Maps: Portion of State Map and portion of Type 10 County Map

cc: J. Michael Long, P.E., Chief of the Asset Management Division, BOMO
Tom Macioce, P.E., Chief Bridge Engineer, BOPD
Richard Runyen, P.E., Bridge Inspection Section Chief, BOMO
NAME], Grade Crossing Unit in the Utilities and Right-of-Way Section **(Only required for Bridges under PUC jurisdiction)**
Brian Hare, Director of the Center for Program Development and Management

pennsylvania
DEPARTMENT OF TRANSPORTATION

DATE: **XX-XX-XX**

SUBJECT: Posting Authorization Request Letter
BMS No. **XX-XXXX-XXXX-XXXX**
SR **XXXX** over **[FEATURE INTERSECTED]**
[TOWNSHIP], [COUNTY]

TO: Richard Runyen, P.E., Chief, Bridge Inspection Section, BOMO

FROM: **[NAME]**, District Executive
District **X**-0

Based **on a load rating analysis of current conditions**, the subject bridge requires a weight limit posting of **XX Tons.** The bridge is to be restricted under §4902(a) of the PA Vehicle Code. The bridge is currently posted for **XX Tons.** This posting is due to **the main bridge members are deficient and cannot carry legal loads safely.** The most recent inspection date is **[MONTH] XX, XXXX.** The Bridge Load Posting Recommendation Form, Load Rating Summary Form and **a diagram of standard vehicles and weights (optional)** are attached for your reference.

Based on the weight restriction, Emergency Vehicles will **be affected**. **Large snow removal vehicles and Fire Trucks will require a special permit.** Also, based on the weight restriction, Haulers will **need to be re-routed.** Currently, **two** Permits are approved to use this route. Alternative routes include **utilizing State Route XXXX and XXXX.** The weight restriction will **have minimal effect on the traveling public; therefore, there is no planned public communication.**

Please review this recommendation and forward to the Director of the Bureau of Maintenance of Operations for their approval. The signature below will provide approval of the proposed weight limit restriction. Should you require any additional information, please contact, **[NAME]**, District Bridge Engineer at **XXX-XXX-XXXX.**

____
[NAME]
District Executive, District **X-0**

Approved by:

____
[NAME]
Director, Bureau of Maintenance and Operations

Encl: Bridge Load Posting Recommendation Form
Load Rating Summary Form
Diagram of Standard Vehicles and Weights (optional)
Site Maps: Portion of State Map and portion of Type 10 County Map

cc: Melissa Batula, P.E., Deputy Secretary for Highway Administration
Tom Macioce, P.E., Chief Bridge Engineer, BOPD
J. Michael Long, P.E., Chief, Asset Management Division, BOMO
[Name], Grade Crossing Unit in the Utilities and Right-of-Way Section **(Only required for Bridges under PUC jurisdiction)**
Brian Hare, Director of the Center for Program Development and Management

pennsylvania
DEPARTMENT OF TRANSPORTATION

1 TON = 2,000 POUNDS

Average Tractor Trailer (Loaded): **40.0 TONS**

Average Dump Truck (Loaded): **36.0 TONS**

Average Cement Truck (Loaded with 10 Cubic yards of Cement): **33.0 TONS**

Average Plow Truck (Loaded): **28.0 TONS**

Average Garbage Truck (Loaded): **25.0 TONS**

Average Fire Truck: **19.0 TONS - 30 TONS**

Average Charter Bus: **16.0 TONS**

Average School Bus: **12.0 TONS**

Average Delivery Truck (Loaded): **6.0 TONS**

Average Ambulance: **5.0 TONS**

Average Standard Truck: **3.0 TONS**

Average Standard Car: **1.5 TONS**

APPENDIX IP 10-A

Annual and Blanket Permit Vehicles
Authorized in PA

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Publication 238 (2021 Edition), Appendix IP 10-A
Annual and Blanket Permit Vehicles Authorized in PA

Table A - Annual Permit Vehicles

Load Type	Description	GVW Limit (lbs)	Authorizing Legislation
34	Excessive damage (steel coils)	125,000	Act 152 of 2002
35A	Crane (self-propelled)	100,000	Act 23 of 1999
35B	Crane (self-propelled)	201,000	Act 23 of 1999
37A	Float/Flat Glass (5 axle)	100,000	Act 23 of 1999 Act 37 of 2001
38A	Waste Coal (overweight)	95,000	Act 151 of 1998
38B	Beneficial Combustion Ash (overweight)	95,000	Act 151 of 1998
38C	Limestone (Overweight)	95,000	Act 152 of 2002
38D	Waste Tires	95,000	Act 81 of 2010
39	Refined Oil (overweight in bulk)	107,000	Act 151 of 1998
41	Particleboard/Fiberboard (overweight)	107,000	Act 151 of 1998
42B	Building Structural Component (overweight)	116,000	Act 37 of 2001
50B	Course of Mfg (overweight) - Hot Ingot/Hot Box	150,000	Act 151 of 1998
50C	Course of Mfg (overweight) - Flat Rolled Steel Coils or Slabs	100,000	Act 151 of 1998 Act 37 of 2001
50D	Course of Mfg (overweight) - Road Tested Crane	150,000	Act 151 of 1998
50E	Course of Mfg (overweight) - Raw Coal	95,000	Act 151 of 1998
50F	Course of Mfg (overweight) - <= One Mile (milk/coal)	95,000	Act 151 of 1998
50G	Course of Mfg (overweight) - Raw Water (6 axle)	96,900	Act 23 of 1999
50H	Course of Mfg (overweight) - Pulpwood/Chips (5 axle)	95,000	Act 23 of 1999
50I	Course of Mfg (overweight) – Cryogenic Liquid	102,000	Act 187 of 2010
50J	Course of Mfg (overweight) - Pulpwood/Chips (6 axle)	107,000	Act 23 of 1999
50K	Course of Mfg (overweight) – Milk (Except Raw Milk)	95,000	Act 34 of 2016
50L	Course of Mfg (overweight) – Eggs	95,000	Act 187 of 2012
50M	Course of Mfg (overweight) – Sugar	95,000	Act 34 of 2016
50X	Course of Mfg (overweight) – Nonhazardous Liquid Glue	105,000	Act 81 of 2010
56F	Containerized Cargo - Refrigerated Meat Products (6-axle)	107,500	Act 50 of 2005

Table B - Blanket Permit Vehicles

Load Type	Description	GVW Limit (lbs)	Authorizing Legislation	Designated Networks
44	Live Domestic Animals	95,000	Act 151, 1998	PA & US Routes, and 4-digit SR's
45	Domestic Animal Feed/Grain	95,000	Act 8, 1996	PA & US Routes, and 4-digit SR's
50A	Course of Manufacture - Raw Milk	95,000	Act 151, 1998, Act 89, 2013	Interstates, PA & US Routes, and 4-digit SR's
56 A-E	Containerized Cargo	90,000	Act 172, 1994	Interstates, PA & US Routes, and 4-digit SR's

APPENDIX IP 10-B

ABAS
Abbreviated Flowchart for Simple Spans

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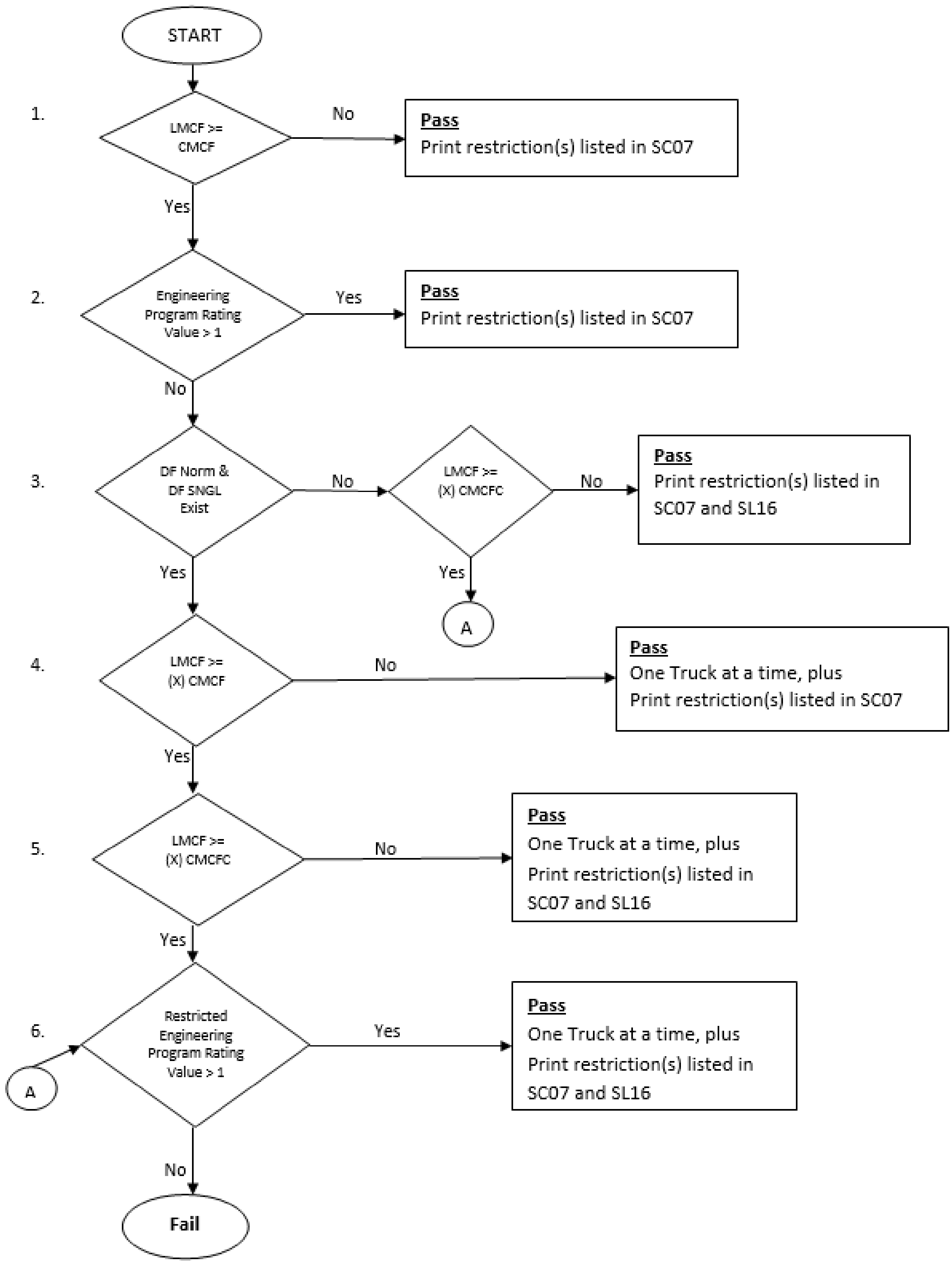
Publication 238 (2021 Edition), Appendix IP 10-B
ABAS Abbreviated Flowchart for Simple Spans



Description

1. The Load Moment Comparison Factor (LMCF) is generated by our Mainframe computer program P4351050 - Comparison of Live Load Moments and Reactions when executed for the permit vehicle.

   The Capacity Moment Comparison Factor (CMCF) is defined as the ratio of the moment capacity of the span to the maximum moment caused by the HS20 loading at the point of maximum moment. CMCF is stored in BMS2 Items SL12 and SL13.

   The restrictions listed in BMS2 Item SC07 are printed every time the bridge/reference is encountered.

2. An engineering program dataset (BAR7, PS3, BOX5, STLRFD, PSLRFD, BXLRFD) is executed for the permit vehicle. The dataset must be referenced in BMS2 Item SS01 - SPAN ID and stored in the Bridge Rating Input Management System.

3. DF NORM is the Live Load Distribution Factor for Moment for Normal traffic. DF NORM is stored in BMS2 Item SL08. DF SNGL is the Live Load Distribution Factor for Moment for traffic restricted to one truck at a time. DF SNGL is stored in BMS2 Item SL09.

3.1 LMCF same as in 1. The Capacity Moment Comparison Factor Comment (CMCFC) is defined as the ratio of the moment capacity of the span to the maximum moment caused by the HS20 loading at the point of maximum moment modified to allow increased capacity. CMCFC is stored in BMS2 Item SL12. If the CMCFC is used, then the restriction(s) stored in SL16 LOAD CONDITIONS will be printed on the permit.

4. LMCF, CMCF same as in 1. (X) is a calculated value from BMS2 Item SL08. (X) = DF NORM / DF SNGL. If (X) is used, then the permit is approved for one truck at a time. ABAS will not allow (X) to be used with the one truck at a time coding that can be stored in SL16 or SC07.

5. LMCF same as in 1. (X) same as in 4. CMCFC same as in 3.1.

6. A restricted engineering program dataset (BAR7, PS3, BOX5, STLRFD, PSLRFD, BXLRFD) modified for one truck at a time and other restrictions desired, is executed with permit vehicle. The dataset must be referenced in BMS2 Item SL17 - SNGL LANE SPAN ID and stored in the Bridge Rating Input Management System. If the restricted engineering program dataset is used, then the restriction(s) stored in SL16 LOAD CONDITIONS will be printed on the permit.

APPENDIX IP 10-C

APRAS Vertical Clearance Flowchart

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Publication 238 (2021 Edition), Appendix IP 10-C
APRAS Vertical Clearance Flowchart

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PART IE: EVALUATION

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Chapter 2 – Bridge Files and Documentation

Chapter 3 – Bridge Management Systems

Chapter 4 – Inspection

Chapter 5 – Material Testing

Chapter 6 – Load Rating

Chapter 7 – Fatigue Evaluation of Steel Bridges

Chapter 8 – Nondestructive Load Testing

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PART IE: EVALUATION

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SPECIFICATIONS

1.1 PURPOSE

The following shall supplement M 1.1.

See IP 1.1 for the Purpose of this Manual. It shall be noted that Part IE of this Manual directly correlates to the MBE. Sections of the MBE which the Department modifies or supplements are listed herein. The absence of a section indicates that the Department accepts that section of the MBE in its entirety.

1.3 APPLICABILITY

The following shall supplement M 1.3.

The provisions of this Manual apply to all Pennsylvania highway structures that qualify as a bridge in accordance with the definition provided in IP 1.5.

1.4 QUALITY

The following shall replace M 1.4.

PennDOT uses a combination of quality assurance/quality control and external quality assurance measures to ensure accurate and consistent inspection data collection, analysis and load rating procedures, and file maintenance. Specific policy on the application of quality measures to Pennsylvania highway bridges can be found in this Manual under Part IP, Chapter 6 – Quality Measures for Safety Inspection.

1.5 DEFINITIONS AND TERMINOLOGY

The following shall supplement M 1.5.

See Glossary and Abbreviations at the beginning of this Manual for definitions and terminology pertinent to this Manual.

1.6 REFERENCES

The following shall supplement M 1.6.

See IP 1.3.2 and IP 1.3.3 for references pertaining to this Manual.

COMMENTARY

IC1.1 'This Manual' as used within the MBE refers to the MBE. 'This Manual' as used within Publication 238 refers to Publication 238.

IC1.5 Some definitions in Publication 238 may differ from those in MBE. The reader shall reference the appropriate definitions and terminology when using each manual.

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SPECIFICATIONS

COMMENTARY

The following shall replace M 2.

2.1I GENERAL

Chapter IP 8 contains PennDOT's requirements for bridge inspection records and files.

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SPECIFICATIONS

COMMENTARY

The following shall replace M 3.

3.1I GENERAL

A detailed description of Pennsylvania's Bridge Management System 2 (BMS2) is contained in Chapter IP 5.

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SPECIFICATIONS COMMENTARY

4.1 INTRODUCTION

The following shall supplement M 4.1.

The Bridge Safety Inspection Program is managed and administrated by the Bridge Unit in each of the Department's Engineering Districts, in conjunction with the bridge owners.

Bridge safety inspection provides information on each bridge that is needed to complete and update each bridge's inventory/inspection database. This data resides in the Bridge Management System 2 (BMS2). This system accepts, stores, updates, and reports physical and operating characteristics for all public bridges in Pennsylvania.

Additional requirements for the safety inspection of PA bridges are to be found in the various sections of this Manual, in the Policies and Procedures Chapters, and as noted below.

4.2 PROVISIONS TO SUPPORT THE NBIS REQUIREMENTS

4.2.1 Bridge Inspection Organization

The following shall supplement M 4.2.1.

For information on the Department's organization for safety inspection of PA bridges see IP 2.1.1.

4.2.2 Qualifications of Personnel

The following shall supplement M 4.2.2.

See IP 2.1.3 for PA requirements for qualifications of personnel.

4.2.3 Inspection Types

4.2.3.1 INITIAL INSPECTION

The following shall supplement M 4.2.3.1.

Additional requirements for PA bridges are contained in IP 2.3.1.

4.2.3.2 ROUTINE INSPECTION

The following shall supplement M 4.2.3.2.

The Routine Inspection should pay particular attention to critical areas of the structure such as at or under deck joints and drains, at bearings, at splices, connections, etc.

Additional requirements for PA bridges are contained in IP 2.3.2.

4.2.3.3 IN-DEPTH INSPECTION

The following shall supplement M 4.2.3.3.

SPECIFICATIONS COMMENTARY

Additional requirements for PA bridges are contained in IP 2.3.4.

4.2.3.4 FRACTURE-CRITICAL MEMBER INSPECTION

The following shall supplement M 4.2.3.4.

Additional requirements for PA bridges are contained in IP 2.4.

4.2.3.5 UNDERWATER INSPECTION

The following shall supplement M 4.2.3.5.

Additional requirements for PA bridges are contained in IP 2.6.2.

4.2.3.6 SPECIAL INSPECTION

The following shall supplement M 4.2.3.6.

Throughout this manual, these inspections are referred to as "Other Special (Interim) Inspections" instead of "Special Inspections." Additional requirements for PA bridges are contained in IP 2.3.5.

4.2.3.7 DAMAGE INSPECTION

The following shall supplement M 4.2.3.7.

Additional requirements for PA bridges are contained in IP 2.3.3.

4.2.4 Inspection Interval

4.2.4.1 INITIAL INSPECTION INTERVAL

The following shall supplement M 4.2.4.1.

Additional requirements for PA bridges are specified in IP 2.3.1.4.

4.2.4.2 ROUTINE INSPECTION INTERVAL

The following shall supplement M 4.2.4.2.

Additional requirements for PA bridges are specified in IP 2.3.2.4.

4.2.4.3 IN-DEPTH INSPECTION INTERVAL

The following shall supplement M 4.2.4.3.

Additional requirements for PA bridges are specified in IP 2.3.4.4.

4.2.4.4 FRACTURE-CRITICAL MEMBER INSPECTION INTERVAL

The following shall supplement M 4.2.4.4.

Additional requirements for PA bridges are specified IP 2.4.7.

SPECIFICATIONS

COMMENTARY

4.2.4.5 UNDERWATER INSPECTION INTERVAL

The following shall supplement M 4.2.4.5.

Additional requirements for PA bridges are specified in IP 2.6.2.4.

4.2.4.6 SPECIAL INSPECTION INTERVAL

The following shall supplement M 4.2.4.6.

Additional requirements for PA bridges are specified in IP 2.3.5.4.

4.2.4.7 DAMAGE INSPECTION INTERVAL

The following shall supplement M 4.2.4.7.

Additional requirements for PA bridges are specified in IP 2.3.3.4.

4.3 NONREGULATORY INSPECTION PRACTICES

4.3.3 Planning, Scheduling, and Equipment

4.3.3.3 EQUIPMENT

The following shall supplement M 4.3.3.3.

Additional guidelines for standard inspection tools and equipment are given in IP 9.

4.3.3.3.1 Access Methods and Equipment

The following shall supplement M 4.3.3.3.1.

The Department owns a fleet of under-bridge inspection cranes to be used for the safety inspection and maintenance of its structures. See IP 1.12 for a description of the crane program.

4.3.4 Inspection Forms and Reports

4.3.4.2 REPORTS

The following shall supplement M 4.3.4.2.

For report requirements for the inspection of PA bridges, see the General Scope of Work documents; Appendix IP 01-F through IP 01-H and Appendix IP 02-D for sign structures.

4.3.5 Inspection Techniques

4.3.5.2 CLEANING

Insert the following after the first paragraph in M 4.3.5.2.

Many bridge problems caused by corrosion and concrete deterioration have become emergencies because the structural deterioration was accelerated

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and/or not discovered during inspection due to debris build-up on bridge members. The high cost of emergency repairs and retrofitting to correct these deficiencies emphasizes the importance of cleaning bridges sufficiently to ensure that the inspection identifies problems in a timely manner. If portions of the bridge inspection cannot be completed to a satisfactory level of intensity because extensive cleaning is required, that cleaning should be scheduled promptly to ensure the inspection can be completed. This shall include cleaning and flushing the bridge deck, horizontal steel surfaces of the superstructure, and any other details that are likely to trap debris, moisture, and bird droppings.

Identify these bridge cleaning needs on the IM inspection form.

4.3.5.4 CRITICAL INSPECTION FINDINGS

The following shall replace M 4.3.5.4.

Critical structural and safety-related deficiencies found during the field inspection and/or evaluation of a bridge should be brought to the attention of the bridge owner immediately. If the deficiency threatens the structural integrity of the bridge to the point that public safety cannot be assured, close the bridge immediately. The bridge should not remain open to pedestrians only unless an evaluation has determined it to be safe for that loading.

Once closed, the bridge may not be re-opened until further evaluation and/or repairs are made to ensure the bridge is safe for its posted weight limit. This decision to re-open the bridge must be made by the Professional Engineer in charge of the inspection because of the public safety issues.

For additional information see IP 2.13.2 through IP 2.14.

4.3.5.5 DECKS

4.3.5.5.1 Concrete Decks

The following shall supplement M 4.3.5.5.1.

Adjacent box beam structures that do not have a separate concrete deck shall have the top flange of the adjacent box beams treated as a deck for the purpose of establishing a deck condition rating (BMS2 Item 1A01). If the box beams have been covered by an asphalt wearing surface, the deck rating may be based on:

- The condition of the top of the beams before the wearing surface was placed, if known.
- The condition of the underside of the superstructure.
- Because the condition of the wearing surface gives an indication of the deck condition, the deck condition rating typically should not be higher than the wearing surface condition rating unless there is strong evidence to support otherwise.

4.3.5.5.5 Expansion Joints

The following shall supplement M 4.3.5.5.5.

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Debris in joints causes damage to the joint. A maintenance item for cleaning and flushing the deck should be recorded to clean the joint. See BMS2 Coding Manual (Pub. 100A) BMS2 Item IM03.

4.3.5.5.7 Drainage

The following shall supplement M 4.3.5.5.7.

Drainage deficiencies on non-redundant structures, especially those with FCMs shall be given a high priority for maintenance. See BMS2 Coding Manual, Publication 100A BMS2 Item IM05.

4.3.5.6 SUPERSTRUCTURE

The following shall replace the first sentence of M 4.3.5.6.

This section includes discussions covering inspection of superstructure components composed of prestressed concrete, reinforced concrete, structural steel, or timber, including bearings, connection devices, and protective coatings.

4.3.5.6.1 Steel Beams, Girders, and Box Sections

The following shall supplement M 4.3.5.6.1.

Guidance and requirements for the inspection of steel bridges considering fatigue and fracture is presented in IP 2.4.

4.3.5.6.2 Reinforced Concrete Beams, Girders, and Box Sections

The following shall supplement the first paragraph of M 4.3.5.6.2.

To aid in locating hairline cracks, wet the concrete surface with small amounts of water and allow to dry. Cracks will be visible due to capillary action of the water in the cracks.

4.3.5.6.3 Prestressed Concrete Beams, Girders, and Box Sections

The following shall supplement the first paragraph of M 4.3.5.6.3.

For Prestressed beams made continuous for live load, examine the beams carefully for cracks in the region within two to three beam depths from interior supports. Diagonal web cracks may be evidence of shear-related problems. Transverse cracks across the bottom flange may be caused by poor bonding or development of the positive moment hook bars and/or the pre-stressing strands. Longitudinal cracking of the bottom flange, especially in box beams, may be an indication of corrosion of prestress strands. The level of inspection intensity and the presence or lack of cracking should be noted in the field reports so that long-term performance of beams can be tracked. Because the details and methods of construction for prestressed beam bridges made continuous for live load are varied, the design, shop drawings, and construction records should be carefully reviewed for the inspection.

To aid in locating hairline cracks, wet the concrete surface with small amounts of water and allow to dry. Cracks will be visible due to capillary action of the water in the cracks.

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IC4.3.5.6.3 Prestressed concrete beams made continuous for live load may be subject to positive moment stresses at interior supports due to forces created by restraint of creep and shrinkage of the beam concrete.

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4.3.5.6.3.1I *Adjacent Non-Composite Prestressed Concrete Box Beams*

The inspection of adjacent non-composite prestressed concrete box beams is to include a review of the items listed below with the findings documented in the inspection report:

Beam Spalls and/or Delaminations:
- Location on beam
- Location within span
- Dimensions of spall (length, width, depth)
- Type and size of steel exposed, if any, (mild or prestressing steel)
- Probable cause of spall
- Date spalls were first discovered

Note: Loose concrete should be removed during inspection to determine extent of spall and to prevent debris from falling on any underpassing route.

Exposed and/or Damaged Strands:
- Location within span.
- Number and size of strands exposed/damaged
- Date strand exposure/damage first noted
- Probable Cause, if different from spall

Web Cracking:
- Number
- Width
- Orientation
- Location within span
- Rust staining in area
- **Note: Cracks directly under or beginning at an open deflection joint parapet in the middle ½ of the span should be suspected as a potential indicator of sudden beam failure and shall be monitored.**

Flange Cracking:
- Number
- Width
- Location – within span and transversely on beam
- Orientation
- Rust staining in area

Other General Information
- Beam camber or sag - Flat or negative beam camber seen in the field may be indicative of internal distress. Measurements can be made to compare to as-built conditions or shop drawings.
- Shear key condition, if visible. Leakage through the shear keys or longitudinal cracks in the pavement shall be noted.
- See Appendix IE 04-C for inspection forms to aid in documentation.

Plan and Cross-Section Sketches of Beams

The bridge inspection and rating file shall contain a plan and cross-section of any beam rated. All beams with exposed strands shall have a cross-section showing the size and locations of exposed and/or damaged strands. For

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IC4.3.5.6.3.1I Without an effective Non-Destructive Evaluation (NDE) tool to detect the extent of strand corrosion and the remaining effective prestressing force, the best information of current beam conditions must be made available to the rating engineer to predict the safe load capacity. Some items, above and beyond the strand loss and concrete deterioration/damage, that may be contributing factors to failures include:
- No concrete deck – when only an asphalt wearing surface and no waterproofing membrane is provided, roadway drainage can be held in the overlay, creating a continually wet environment for corrosion.
- Without a composite concrete deck, redundancy of beams is reduced.
- Shear keys – poor quality grout does not provide an effective load transfer mechanism between beams. The effectiveness of the shear key can deteriorate with age.
- Transverse tie rods – without significant posttensioning and/or effective shear keys, tie-rods cannot be fully depended upon for load sharing, especially for fascia beams.
- Severe skew (< 60º)
- Asymmetrical loss of prestressing force and/or concrete quality due to damage or corrosion.
- Open joints between parapet sections can direct roadway drainage onto the outside face of the fascia beam and provide a point

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consistency, refer to Appendix IE 04-D for examples of beam sketches with exposed or damaged strands for documentation during inspection and analysis.

Adjacent non-composite prestressed concrete box beam bridges with damaged strands or concrete shall be considered high priority for inspection and ratings.

4.3.5.6.4 Timber Systems

The following shall supplement M 4.3.5.6.4.

Stressed timber superstructures should receive special attention during inspections. Stressed timber superstructures consist of longitudinal timber planks (set on edge) that are squeezed together by transverse post-tensioning high strength steel bars. This post-tensioning makes the timber planks act together as if the bridge were a solid slab. Because of the potential for creep of the planks or the crushing of the wood under the anchor plates for the transverse post-tensioning, over time the applied force may relax and the "slab" action may be reduced or lost, resulting in a loss of live load capacity.

Two items that may be indicative of the ongoing structural performance of a stressed timber superstructure bridge are:

- Live Load Deflection –Should be limited to L/500 as recommended in the AASHTO Specifications.
- Bar Force in the Post-tentioned Tendons – For bridges of sawn lumber, the bar force should be checked annually for the first 2 years and subsequently every 2 years. After the bar force stabilizes, this period may be extended to 2 to 5 year intervals.

4.3.5.6.6 Trusses

The following shall supplement M 4.3.5.6.6.

Check for global buckling of truss compression members along their length and also check for localized buckling of truss member elements. Missing/deficient lacing bars and/or batten plates on built-up truss compression members can severely limit their capacity against buckling.

Refer to Appendix IE 04-A for blank forms to aid in the inspection of truss bridges.

GUSSET PLATES

Truss gusset plates shall be inspected to obtain the necessary information to perform a load rating analysis, and examined for the following deficiencies:

Out-of-plane distortion (bowing): Gusset plate distortion can be caused by overstressing of the plate due to overloaded vehicles or inadequate bracing during initial erection. Pack rust may be another cause for distortion (bowing). Bowing due to pack rust is generally directly proportional to the amount of pack rust between the plate and the member. Distortion may occur at the edges or internal regions of the plate.

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of reduced beam stiffness or stress concentration.

IC4.3.5.6.4 The Transportation Research Record 1740 Paper No. 00-1191 entitled "Field Performance of Stress-Laminated Timber Bridges" provides a good overview of this bridge type and was the source for the recommendations in the second paragraph.

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Use a straightedge to evaluate and quantify any distortion. The plate distortion shall be measured as the distance between the straightedge and the plate.

Corrosion and section loss: Corrosion is formed on steel surfaces due to moisture penetrating the protective coating. Areas that trap debris or hold water are most susceptible to corrosion and section loss. Proper visual inspections can be impeded due to debris and heavy rust. Areas with corrosion should be cleaned and evaluated.

The detection of corrosion in gusset connections is often hampered by its configuration. The insides of gusset plates, which are perhaps the most susceptible to corrosion, are often difficult to visually inspect. Therefore, nondestructive evaluation (NDE) technologies such as D-meters and ultrasonic equipment shall be used at locations where visual inspections may be inadequate to assess and quantify conditions such as section loss due to corrosion. Inspectors are to identify locations requiring NDE and recommend the appropriate type of NDE to be used.

Cracked welds: Welds on tension members are considered fatigue prone details because when/if the weld cracks, there is a potential for the weld to propagate into the base metal.

Thoroughly document partial and full length cracked tack welds. Removal of partial length cracked tack welds is recommended.

Slippage or cracks at mechanical connections: Depending on the detail, pack rust causing plate separation can lead to overstressed mechanical fasteners. Rivet or bolt heads can "pop" off (tension failure) under the extreme force generated by pack rust. Also, rivets or bolts may be missing from the connection.

Inspect fasteners by hammer sounding, and observe connection for slipped surfaces around individual fasteners. Inspect around gusset plate fastener heads for evidence of cracks emanating from the fastener holes. Any crack found in a gusset plate should be considered critical.

Repairs/retrofits: Structural steel repairs and retrofits are used to strengthen deteriorated and bowed gusset plates.

All repairs/retrofits should be inspected for alignment, deterioration, pack rust, etc. as a means to ensure the repairs/retrofits are functioning as intended.

4.3.5.6.7 Cables

The following shall supplement M 4.3.5.6.7.

Note any abrasions on the cable due to contact with steel pieces. Cables consisting of helically wrapped strands will rotate clockwise and counterclockwise under live load deflection. If these cables are in contact with steel pieces that do not move in unison with the cable, this rotation will effectively saw through the outer strands of the cable.

4.3.5.6.8 Diaphragms and Cross-Frames

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The following shall supplement M 4.3.5.6.8.

Diaphragms and cross frames in curved steel multi-girder bridges and in straight steel bridges with skew angles less than 70° can carry significant loads and are considered to be main structural members. Because the diaphragms and cross-frames are essential to the structural integrity of curved girder bridges, especially note deficiencies such as buckling, and deteriorated or cracked members and connections and assign an appropriate priority for their repair.

4.3.5.6.9 Lateral Bracing, Portals, and Sway Frames

The following shall supplement M 4.3.5.6.9.

Note any missing or deteriorated connection bolts or rivets.

Any bracing or cross frame details with welds intersecting with or ending near welds on the main girder may be subject to fracture without notice. See IP 2.4.11.2 for additional guidance on such details.

4.3.5.6.11 Pins and Hangers

The following shall supplement M 4.3.5.6.11.

On many of PA's bridges with pin hangers, secondary or "catcher" systems have been installed to provide redundancy in the event of a pin hanger failure. Typically, these systems were designed to be effective only if the pin/hanger failed and must be monitored to ensure they allow adequate thermal movement of the bridge. All members, connections, and other appurtenances associated with these systems should be inspected as part of the fracture critical inspection. Auxiliary neoprene bearings were used on the catcher beam to limit the free fall of the suspended girder and reduce its impact loading on the catcher system. This auxiliary bearing must be monitored to ensure it is in the proper position as noted on the design/shop drawings.

4.3.5.6.12 Bearings

The following shall supplement M 4.3.5.6.12.

Abnormal or unusual gap measurements at deck expansion joints may be an indication of frozen or improperly functioning bearings as described in IE 4.3.5.6.12.1I. This may also be an indication of substructure deflection or movement. For bridge joints with movements greater than 3", it is good practice to record the gap with each inspection to establish long-term expansion movements. Additional readings during different seasons at extreme temperatures may be needed for a more complete assessment.

4.3.5.6.12.1I *Rocker Bearings*

Rocker bearings are generally designed to be set at 68° F, which means that the rocker bearings should be vertical (no tilt) at 68° F by design. However, due to fabrication and construction tolerances, rocker bearings in the vertical position at ambient temperatures up to 15° F higher and lower than 68° F would still be acceptable. The normal behavior of rocker bearings is to tilt away from

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IC4.3.5.6.12.1I There have been two known incidents involving bridges with steel rocker bearing that have exceeded the available movement limit. The first incident occurred in August 2005 carrying I-787 Ramp

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the fixed bearing for that span unit when the temperature rises and to tilt toward the fixed bearing for that span unit when the temperature falls.

Abnormal behavior refers to bearings that are in the contracted position (tilted toward the fixed bearing) in warm weather (above 68° F) or in the expanded position (tilted away from the fixed bearing) in cold weather (below 68° F). In cases where there are two lines of expansion bearings from separate, adjacent span units at a common support, an indication of abnormal behavior is identified by bearings being tilted in the same direction instead of converging or diverging. A rocker bearing that exceeds the acceptable limit of tilt or is bearing on the outer one-quarter width of the rocker for a pier (outer one-tenth width for an abutment) is also an abnormal condition. Abnormal behavior of the bearings may indicate movement of the substructure on which the rocker bearing is founded, movement of the substructure where the fixed bearings are located, or loss of bearing freedom of movement. Note which of these cases may have caused the abnormal behavior.

Any rocker bearing that exceeds the acceptable limit of tilt, (i.e., the rocker is bearing on the outer one-quarter of its width at a pier or the outer one-tenth of its width at an abutment) is considered a critical deficiency.

Critical and High Priority deficiencies found during the inspection should be documented appropriately with photographs and the required information obtained in Appendix IE 04-B. Critical Deficiencies should be brought to the attention of the bridge owner immediately in accordance with Article IE 4.3.5.4. Additionally, for every inspection performed on bridges having rocker bearings, the information in Appendix IE 04-B shall be included in all inspection reports for each location where rocker bearings are present and become a permanent part of the bridge file.

Contact the Assistant District Bridge Engineer-Inspection immediately if a pier with two lines of expansion rockers has any rockers bearing on the outer one-quarter width.

The amount of allowable tilt varies with respect to bearing geometry, expansion length, bridge type, and ambient temperature. To compare the actual tilt to the allowable tilt, the inspector should determine the allowable tilt by completing the tables included in Appendix IE 04-B for initial, routine, in-depth and special inspections. A spreadsheet is available on the BMS2 Home screen to perform the rocker bearing calculations.

Initial readings should be taken after any bearings are reset or if replacement of the deck joints occurs. This will provide a baseline reading for the bearing measurements.

The flexibility of the pier also makes it susceptible to movement from forces generated by temperature change in the superstructure when the bearings lose functionality. Intended functionality or freedom of movement may be restrained or lost by pack rust at bearing surfaces, deck expansion joints that do not allow full range of movement, etc. A high degree of flexibility allows for large deflections at the top of the pier due to the unintended transfer of force to the substructure through improperly functioning rocker bearings. Therefore, pier stems / columns should be inspected for abnormal movement/deflection and flexural cracking; if deemed necessary, pier movement should be monitored with

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Northbound in Albany, New York. The other incident occurred in February 2008, carrying SR 2085 in Pittsburgh, PA. Some of the common characteristics of both bridges at the pier line involving the bearings that exceeded available movement limit are:

- Pier fixity consisted of expansion – expansion
- Piers were relatively tall (greater than 61 feet) and thus relatively flexible compared to adjacent piers
- Inspection documentation over several cycles recorded the bearings being oriented in a parallel displacement configuration instead of diverging or converging.

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surveys. Compare center-to-center of bearing span lengths with the as-built geometry for indications of pier movement.

Excessive abutment rotation/movement may also cause rocker bearings to exhibit abnormal behavior with respect to tilt. Plumbness of the abutment should be checked with a plumb bob and/or survey if necessary.

The physical condition of the bearing (state of corrosion, cracked welds, paint condition, etc.) is assessed independently of the required maintenance to restore the bearing to a fully functioning, as-designed, service state.

Rocker bearing deficiencies are divided into two categories when assigning Maintenance Actions (BMS2 Item Number IM03) and Maintenance Priority Codes (IM05) to restore a rocker bearing to its functioning service state:

1. Normal (due to wear and tear)
2. Critical and High Priority (due to abnormal behavior and extreme functional deficiencies)

Maintenance actions such as cleaning, lubricating, resetting, replacement, etc., and their priorities, as required and due to normal deficiencies should be assigned considering the vulnerability of the structure with respect to structural redundancy, bearing seat width, and minor abnormal behavior. See PUB100A, "IM Inspection – Maintenance" for general guidelines in assigning these actions and priorities. The inspector must use good judgment when assigning high priorities and justify such priorities with adequate documentation. Also, consider adjusting maintenance priority based on ADT of the bridge, feature under the bridge, flexibility of the substructure, condition of the bearings, number of bearings in a line with excessive tilt, type of superstructure, ability of the bearing to freely move, and evidence of pintel failure. In addition, flexible piers with two lines of expansion bearings shall be given extra scrutiny and maintenance priority shall be assigned accordingly.

Critical and high priority deficiencies of rocker bearings should also be addressed considering structural vulnerability and by assigning Maintenance Actions and Maintenance Priority Codes to correct any noted problems; however, the cause of the functional deficiency should also be addressed. The cause may be due to a more serious structural problem (substructure movement/settlement, for instance) which may require repairs in addition to rocker bearing repairs. The structural problem, if not addressed, may increase structural vulnerability which could lead to more serious consequences such as partial or complete failure of the bridge.

Address the following deficiencies and take action as indicated:

<u>Priority 0 - Critical</u>

- Critical Rocker Bearing Tilt: Applicable where there are one or two lines of expansion rocker bearings on a single pier or abutment and one or more bearings in a line have reached the maximum movement capacity, bearing on the outer one-quarter of the rocker plate on piers (outer one-tenth of the rocker plate for rockers on abutments).

  Remediation options include (but are not limited to):
  - Install temporary supports and assign appropriate monitoring frequency as a temporary measure (note: this option does not alleviate unintended transfer of horizontal force to the

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substructure if bearing freedom of movement is lost). Adequately designed steel or timber cribbing can be used as a temporary measure to mitigate a Priority 0 to a Priority 1; however, a 6 month Other Special (Interim) Inspection will still be required. The monitoring should be completed during extreme temperatures. The purpose of the re-inspection during extreme temperature is to ensure the condition has not gotten worse.

- Reset the bearings by one of the following means: reposition the sole plate by removing the existing welds and re-welding the sole plate to the girder, enlarge and/or slot the anchor bolt holes in the masonry plate to adjust its location, or re-fabricate a masonry plate with the adjusted pintel hole locations.

- Bearing Replacement.

<u>Priority 1 – High Priority</u>

- Potential to Reach Critical Rocker Bearing Tilt: The bearing rotation exceeds the rotation limit for the ambient temperature; however, the bearing has not exceeded the maximum rotation capacity. Applicable when movement analysis indicates a potential for one or more bearings to reach or exceed its maximum movement capacity, potentially bearing on the outer one-quarter of the rocker plate on piers (outer one-tenth of the rocker plate for rockers on abutments).

  Remediation options include (but are not limited to):
  - A follow-up Other Special (Interim) Inspection should be completed at the temperature extreme that is anticipated may cause the bearing to exceed the maximum rotation capacity.
    - Revise the maintenance priority from a Priority 1 to a Priority 0 if the rotation of bearings at the extreme temperature exceeds the maximum rotation capacity.
    - Consider revising the maintenance priority from a Priority 1 to a Priority 2 if the bearings are still within the maximum rotation capacity at the temperature extreme. The bearings can be monitored during scheduled Routine and Interim Inspections if assigned a Priority 2.

  - Install temporary supports and assign appropriate monitoring frequency (note: this option does not alleviate unintended transfer of horizontal force to the substructure if bearing freedom of movement is lost). Adequately designed steel or timber cribbing can be used as a temporary measure to mitigate the Priority 1 to a Priority 2. The bearings can be monitored during scheduled Routine and Interim Inspections.

  - Reset the bearings by one of the following means: reposition the sole plate by removing the existing welds and re-welding the sole plate to the girder, enlarge and/or slot the anchor bolt holes in the masonry plate to adjust its location, or re-fabricate a masonry plate with the adjusted pintel hole locations.

  - Bearing Replacement.

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Extreme temperature is defined as ambient temperature greater than 80° F, less than 40° F, or a temperature difference of 40° F or more from the original inspection.

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- Rocker Bearing Debris Restriction: Rocker bearings located on piers or abutments with heavy accumulations of pack rust, corrosion, and/or debris under one or more rocker could potentially limit or prevent the bearing from operating as it was intended during structure expansion and contraction.

  Remediation options include (but are not limited to):
  - Monitor the bearings and substructure at a 6-month frequency with an Other Special (Interim) Inspection until the repairs are made. The monitoring should be completed during extreme temperatures when possible.
  - Clean and lubricate the bearing to restore proper function. The bearing may need to be completely removed and pack rust removed by mechanical means to properly restore the function of the bearing.
  - Bearing Replacement.

<u>Priority 3 – Schedule</u>

- Abnormal Rocker Bearing Tilt: The bearings are within the acceptable limits at the ambient temperature; however, there is at least one line of expansion rocker bearings and one or more bearings in a line exhibit tilt in the opposite direction indicated by ambient air temperature. Rocker bearings in the contracted position (tilted toward the fixed bearing) in warm weather (ambient temperature above 68° F) or in the expanded position (tilted away from the fixed bearing) in cold weather (ambient temperature below 68° F.)

  Remediation options include (but are not limited to):
  - Monitoring the bearing rotation during regularly scheduled Routine inspections as long as the bearings stay within acceptable limits at the ambient temperature.
  - Reset the bearings by one of the following means: reposition the sole plate by removing the existing welds and re-welding the sole plate to the girder, enlarge and/or slot the anchor bolt holes in the masonry plate to adjust its location, or re-fabricate a masonry plate with the adjusted pintel hole locations.
  - Bearing Replacement.

- Rocker Bearing has exceeded 50% of Movement Capacity: The bearings have exceeded 50% of the movement capacity at the ambient temperature.

  Remediation options include (but are not limited to):
  - Monitoring the bearing rotation during regularly scheduled Routine inspections as long as the bearings stay within acceptable limits at the ambient temperature.
  - Reset the bearings by one of the following means: reposition the sole plate by removing the existing welds and re-welding the sole plate to the girder, enlarge and/or slot the anchor bolt holes

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in the masonry plate to adjust its location, or re-fabricate a masonry plate with the adjusted pintel hole locations.

- Bearing Replacement.

All repairs and superstructure jacking procedures must be prepared, signed, and sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania.

4.3.5.6.15 Arches

The following shall supplement M 4.3.5.6.15.

Check arch spandrel walls for separation from the arch ring and leakage of fill material. Check vertical and longitudinal alignment of the spandrel wall and note any bulging or lateral displacement. Broken or clogged drainage through the arch fill can lead to a long term loss of fine materials in the fill.

The occurrence of winter weather freeze-thaw cycles increases the likelihood of accumulated moisture in the poorly drained fill material of stone masonry structures. As a result, the stability of the structures can be adversely affected to the point of failure. Routine inspection of these structures is warranted during freeze-thaw cycles so that the Department can identify, prioritize and complete maintenance work. Routine inspection schedules for state-owned stone masonry arches should be adjusted so that they are inspected during the freeze-thaw cycle. The biennial NBI inspection shall be performed between April 1 and April 30 in order to have these structures evaluated just after the seasonal freeze-thaw cycle.

In addition, all stone masonry arches in poor condition must have an annual Other Special (Interim) inspection performed each year to ensure the safety of these structure types. The Other Special (Interim) inspection shall include all stone masonry portions of the structure.

For both the routine and interim inspections, the inspection forms included in the Stone Masonry Arch Condition Rating Guidelines (Appendix G of BMS2 Coding Manual, Publication 100A) must be used.

4.3.5.7 SUBSTRUCTURE

4.3.5.7.2 Retaining Walls

4.3.5.7.2.1I *Mechanically Stabilized Earth Retaining Walls*

Mechanically Stabilized Earth (MSE) retaining walls should be inspected for evidence of wall movement including rotation and settlement.

- Examine barrier and moment slab for evidence of movement as well as the MSE wall for evidence of bulging, bowing or panel offset.
- Perform a survey if movement is suspected to compare to initial inspection data to gauge amount of movement.
- Examine the roadway above MSE walls for indications of failing pavement or tension cracking. These may indicate a loss of fill.

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- For MSE walls in front of sloping backfill, the crest of the embankment should be investigated for soil stress or failure, both of which may indicate settlement or wall movement.

The joints between panels of MSE walls are to be inspected and examined for loss of backfill, change in spacing, and indications of settlement. The specification requirement for joint spacing is a maximum ¾".

- Inspect walls for evidence of backfill loss (piles of aggregate at the base of the wall).
- Indicate visibility of backfill or fabric behind the panel through joints.
- Examine for evidence of damage to the geotextile fabric, if visible.
- Look for variation in joint spacing. Note vegetation growing in joints.
- Vertical slip (expansion joints) used on long lengths of walls should be investigated similar to panel joints. The initial spacing at the slip joint should be determined from design, shop or as-built drawings.

Wall panels shall be checked for cracking, spalling, other forms of deterioration, and collision damage.

Drainage systems through or along MSE walls should be inspected to verify water is free flowing into and out of the appropriate facility.

- Ensure that weep holes are free draining.
- Inspect all inlets to verify water is draining into the inlet, and flowing freely to the inlet and out of the outlet. Examine inlets for cracks.
- Inspect visually or use down hole cameras (as appropriate) for all culverts and pipes contained or having portions in, behind, or above the MSE wall mass and for pipes or culverts which run above, adjacent to, or outlet through the MSE walls to verify pipes are free draining and water is flowing through (and not under or around) the pipe. Examine drainage pipes for cracking or damage with emphasis on areas where water may flow, or is flowing, into the MSE wall soil mass. Inspect outlet ends to verify free drainage or for evidence of migration of fill or other material.
- Inspect swales above the MSE wall. Verify rock fall or other materials (trees, etc.) are not blocking, redirecting, or restricting the flow of water through the drainage ditch above the MSE wall to the appropriate receptacle.
- Inspect collection and outlet basins to verify water is draining freely. Look for any signs of infiltration or migration of material which may prevent water from draining from the wall.
- Identify inappropriate appearance of water along the base of the wall (i.e., if water is appearing when weather conditions have been particularly dry). Note areas where there is inappropriate collection and/or lack of drainage for water along the length of the MSE Wall.
- Note erosion of soil along the base of the wall exposing or undermining the leveling pad.

4.3.5.7.2.2I *Geosynthetic Reinforced Soil Retaining Walls*

Geosynthetic Reinforced Soil (GRS) retaining walls should be inspected for evidence of wall movement, loss of backfill and other visible forms of

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deterioration. These walls are similar to MSE walls so the guidance outlined in IE 4.3.5.7.2.1I shall be followed as applicable.

4.3.5.7.3 Piers and Bents

The following shall supplement M 4.3.5.7.3.

Where piles are exposed by scour or by design, check piles for lateral stability. Inspect and evaluate piles for both local buckling of the web/flange elements and global buckling of the exposed pile length.

4.3.5.7.4 Bridge Stability and Movements

Add the following at the end of the third paragraph of M 4.3.5.7.4.

For large embankments with steep slopes, movements may be caused by deep failure of the embankment and/or underlying soil. A thorough review of foundation information and additional testing may be needed to ascertain the problem. One method for measuring slope movement is to install slope inclinometers and provide long-term monitoring.

4.3.5.8 SCOUR AND WATERWAY INSPECTIONS

4.3.5.8.2 Underwater Inspection

The following shall supplement M 4.3.5.8.2.

For additional information on underwater bridge inspections, see IP 2.6.2 and the General Scope of Work for Underwater Inspection of Bridges in Appendix IP 01-H.

4.3.5.8.4 Channel Protection Features-Dolphins and Fenders

The following shall supplement M 4.3.5.8.4.

The navigational controls are to be inventoried and noted in BMS2 Items 4A21-4A24 and 4A07. The conditions of these controls should be noted in the inspection report with the substructure unit(s) they protect.

4.3.5.10 CORRUGATED METAL PLATE STRUCTURES

The following shall supplement M 4.3.5.10.

The following items shall be inspected and recorded during inspection of Corrugated Metal Plate (CMP) structures:

- Structure length, maximum span length, barrel length, height of cover, and number of barrels
- Evidence of roadway settlement or repair, such as pavement distress or cracks, sign of recent repairing and repaving, and guardrail sagging over the culvert.
- Type and condition of end segment treatment
  a. Type of Headwall with or without traffic barrier
  b. Type of Wingwall or natural slope
- Installation and previous inspection records for comparison.
- Generate a stream sketch to capture current conditions:

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a. Upstream and downstream stream alignment
b. Inlet and Outlet scour condition, (rip-rap, failed headwalls)
c. Culvert blockage/debris
d. Erosion indicated

- Shape or geometry of culvert. Document the location and extent of the observed deterioration (detailed measurements required). It is recommended measurements be taken using a survey rod with a self-leveling cross-line laser level set on a tripod.
  a. Crown flattening
  b. Bulging
  c. Side bow
- Metal plate thickness and condition
  a. Extent of corrosion
  b. Cracking
  c. Missing bolts
- Infiltration and loss of structural backfill through joints or hole through the culvert.

Corrugated metal arch culverts shall be inspected to obtain the necessary information to estimate the current condition rating and examined for the following deficiencies:

Out-of-plane distortion (bulging): Metal arch barrel distortion can be caused by overstressing of the plate due to overloaded vehicles or section loss. Pack rust may be another cause for distortion (bulging).

An important feature to observe and measure when inspecting corrugated metal pipe culverts is the cross-sectional shape of the culvert barrel. Any distortions need to be documented. When distortion or curve flattening is apparent, the extent of the distorted area, in terms of length of culvert affected, width of defect (measured along arc length), and the location of the flattened area should be documented. Baseline measurements shall be taken at the first observance of a distortion if no baseline was previously established (e.g., at the time of installation). New measurements shall be taken at all subsequent inspections and compared to the baseline to monitor any changes.

SPECIFICATIONS COMMENTARY

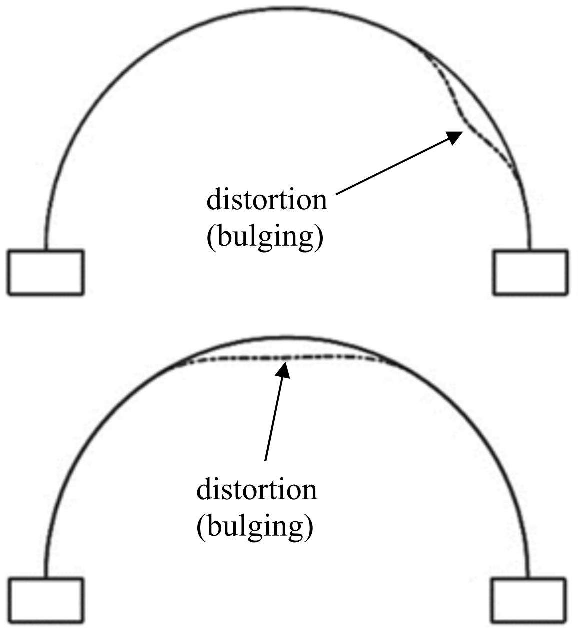

Figure IE 4.3.5.10-1 – Examples of Out-of-Plane Distortions in Corrugated Metal Arch Culverts

When distortions are apparent, assign Maintenance Priority Codes as follows:

> 3″ distortion caused by corrosion – Code 0 (critical)
> 2″ ≤ 3″ distortion caused by corrosion– Code 1 (high priority)
≤ 2″ distortion caused by corrosion– Code 2 (priority)

Corrosion and Section Loss: Corrosion is formed on steel surfaces due to moisture penetrating the protective coating. Segment seam or bolted joints are typically the places most susceptible to corrosion.

Excessive section loss along longitudinal seams due to corrosion and missing or loose bolts/nuts will result in reduced capacity (lower load ratings) or even culvert collapse. Corrosion loss can be estimated using NDE technology such as D-meters or using engineering judgment.

Document the corrosion and identify the worst 4 ft. length (see Figure IE 4.3.5.10-3). Count the corrugations with holes and measure/estimate the section loss in the other corrugations.

SPECIFICATIONS COMMENTARY

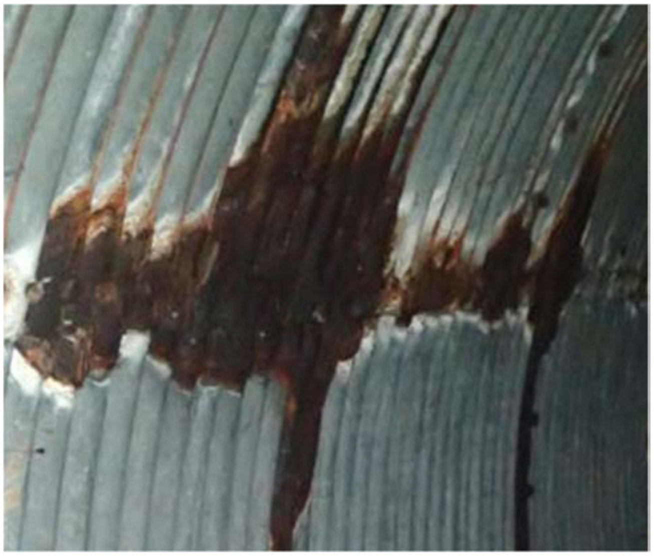

Figure IE 4.3.5.10-2 – Example of Corrosion and Section Loss Along Longitudinal Bolt Line

Assign Maintenance Priority Codes for corrosion as follows:

- Severe corrosion along a 4 ft. length with visible holes in approximately 50% or more of the corrugations – Code 0 (critical)
- Serious corrosion along a 4 ft. length with some minor holes – Code 1 (high priority)
- Advanced corrosion along a 4 ft. length – Code 2 (priority)

If a Priority Code 2 is assigned, estimate the remaining useful life of the culvert. To simplify the estimation, section loss in each corrugation may be categorized (e.g., 100%, 75%, 50%, 25% and 0%). The BMS2 Coding Manual, Publication 100A provides an example remaining life calculation (see Section 3.0, IM Screen, Item IM05, Priority Code 2, Culvert Examples). There is also a spreadsheet available for use on the BMS2 homepage.

Assign Maintenance Priority Codes for bolt deficiencies as follows:

- Approximately 50% or more bolts/nuts missing or ineffective over a 4 ft. length – Code 0 (critical)
- Consecutive bolts/nuts missing for a length of 1 ft. to 2 ft. – Code 1 (high priority)

SPECIFICATIONS COMMENTARY

Example Corrosion Assessment:

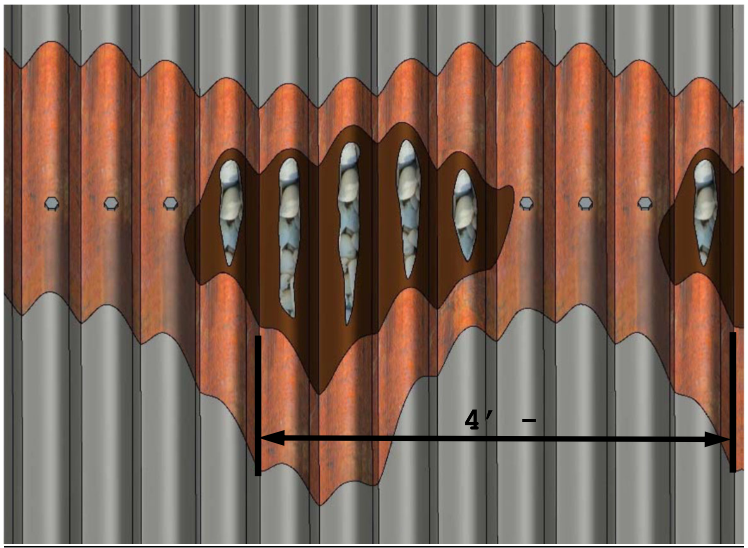

Figure IE 4.3.5.10-3 – Documentation of Corrosion and Section Loss Along Longitudinal Bolt Line

Observation: severe corrosion along longitudinal bolt line with visible holes in 5 of 8 corrugations in the worst 4 ft. length

5 / 8 = 63% of corrugations

Conclusion: with holes in more than 50% of the corrugations in a 4 ft. length, Priority Code 0 is recommended.

Additional requirements for PA bridges are contained in IP 2.5.2. See Appendix IE 04-E for inspection forms to aid in the inspection of corrugated metal plate culverts. For suggested repairs, see Publication 55, Bridge Maintenance Manual.

4.3.6 Complex Bridge Inspections

4.3.6.5 PRESTRESSED CONCRETE SEGMENTAL BRIDGES

The following shall supplement M 4.3.6.5.

Check for corrosion staining especially at segment joints. Note any clogged drain holes or any standing water in box sections.

4.3.7 Fatigue-Prone Details and Fracture-Critical Members

The following shall supplement M 4.3.7.

Additional requirements for PA bridges are contained in IP 2.4.

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4.3.8 Data Collection for Load Rating

The following shall supplement M 4.3.8.

Additional requirements for load rating analysis for PA bridges are contained in IP 3 and IE 6.

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SPECIFICATIONS COMMENTARY

5.1 GENERAL

The following shall supplement M 5.

Additional requirements for PA bridges are contained in IP 3.7.

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SPECIFICATIONS COMMENTARY

6.1 SCOPE

The following shall supplement M 6.1.

Additional requirements for PA bridges are contained in IP 3.

6.1.2 Condition of Bridge Members

The following shall supplement M 6.1.2.

Built-up compression members consist of compression elements (channels, angles, plates, etc.) and connecting elements (lacing bars, batten plates, etc.). In addition to recording the condition of the compression elements, record the condition of the connecting elements. Built-up compression members shall have all their connecting elements intact and properly connected to ensure that the entire member is acting to resist the load. If connecting elements have severe section loss, are not properly connected, or are missing, record the location and length of this deficiency. This information will be used to check local buckling of compression elements, which may control the capacity of the built-up compression member.

6.1.4 Bridges with Unknown Structural Components

The following shall replace the first sentence of M 6.1.4.

For redundant bridges where necessary details, such as reinforcement in a concrete bridge, are not available from plans or field measurements, a physical inspection of the bridge by a qualified inspector and evaluation by a Professional Engineer is sufficient to determine the Inventory and Operating ratings. These ratings shall be recorded in the BMS2 and the bridge inspection as Engineering Judgment. Requirements for Engineering Judgement load ratings for PA Bridges are contained in IP 3.6.1.1.

6.1.5 Component-Specific Evaluation

6.1.5.2 SUBSTRUCTURES

The following shall supplement M 6.1.5.2.

Reinforced concrete piers shall be load rated if they show signs of distress such as excessive concrete spalling, excessive reinforcing steel corrosion, reinforcing bars not engaged by concrete, or show signs of movement, or exhibit other distress, as directed by the Department. Record the extent and depth of spalling, loss of reinforcing steel cross-sectional area, loss of concrete cross-section, and distressed locations. Calculate the remaining cross-sectional area of the concrete component and the reinforcing steel.

Perform pier load ratings based on operating levels for reinforced concrete members as stated in the current AASHTO Standard Specifications for Highway Bridges, Section 8, or AASHTO LRFD Bridge Design Specifications, Section 5, as supplemented by PennDOT Design Manual 4, or by the strut and tie approach specified in IE 6B.5.3.4I.2 to determine ratings. For shear analysis using working stress methods, do not exceed the limitations contained in the 1973 AASHTO Specifications. The strut and tie method uses lower effective concrete strengths and lower resistance factors than traditional analysis methods

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and therefore, will not predict higher capacities in all cases. However, the strut and tie model may be beneficial where deficient shear reinforcement is compensated by the reserve capacity in the flexural reinforcement or vice versa and in cases with concentrated loads close to supports.

6.1.5.2.1I Analysis of Reinforced Concrete Pier Caps

Determine applicable loads, load factors and load cases for the existing pier caps. Actual wearing surface thicknesses shall be used in evaluating the pier caps. Rate the pier caps without the effects of longitudinal loads from live load, i.e. braking forces. Do not include the effects of wind when rating the pier caps.

6.1.5.2.1I.1 *Pier Cap Rating General Guidance*

The provisions of IP 3 shall apply when load rating reinforced concrete pier caps. Analysis programs which are typically used to analyze new piers may be used to analyze existing piers which show signs of distress. Modifications of the input parameters will be necessary to account for the deterioration of existing concrete and reinforcing steel. Field measurements of all bearings shall be taken to determine if the bearings were placed according to the plans. The bearing locations shall be modeled in the as-built condition to account for any eccentricity which may exist.

Rating calculations will typically need to be computed outside of the program. The rating engineer shall obtain unfactored/factored force effects from the program to compute the ratings. Obtain the concurrent shear and torsion forces for the rating analysis and remove the effects of torsion if torsion was not considered in the original design. Consider the beneficial effects of axial compression on the shear capacity of members per AASHTO SD Equation 8-50, if applicable.

Account for the vertical component of the inclined flexural compression and of the inclined flexural tension force in the tapered members using the equation below. For tapered members, the design shear force shall be adjusted as follows:

$$V_{u,adj} = V_u\left(1 - \frac{M_u}{V_u \cdot d} \cdot \tan\psi\right)$$

where: M_u = absolute value of the factored moment
V_u = absolute value of the factored shear
d = effective depth
ψ = sum of angles of compression face and of centroid of flexural reinforcement in tension relative to member axis. Angle ψ is taken as positive if magnitude of moment and depth of member increase or decrease in same sense, negative otherwise.

If shear controls rating, the concrete load near the column may be neglected per AASHTO LRFD AD 5.7.3.2, as this force is transferred by a compression diagonal to the column.

6.1.5.2.1I.2 *Strut-and-Tie Models of Reinforced Pier Caps*

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IC6.1.5.2.1I.2 Strut-and-tie models can be made externally determinate by proper selection of support reactions. This may require replacing some support

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The flow of forces in a reinforced concrete structure or a portion of a reinforced concrete structure may be approximated by a truss composed of compression members (struts) and tension members (ties) which are connected at nodes. The load rating of reinforced concrete piers shall be based only on the ratings computed in the general zone; do not compute ratings for local zones.

The selected truss model shall establish equilibrium between internal and external forces applied to the structure or the portion of the structure considered.

Tie forces are resisted by reinforcement. Orientation and the centroid of such reinforcement shall coincide with the corresponding ties in the strut-and-tie model.

Strut forces shall be resisted by compressive stresses in the concrete. Select strut dimensions such that the strut forces do not exceed the strut capacities and all struts fit within the boundaries of the portion of the structure considered. The strut area shall be determined by considering both the available concrete area and the anchorage conditions at the ends of the strut, as shown in Figure IE 6.1.5.2.1I.2-1. When a strut is anchored by reinforcement, the effective concrete area may be considered to extend a distance of up to six bar diameters from the anchored bar, as shown in Figure IE 6.1.5.2.1I.2-1(a).

Transverse tensile stresses due to lateral dispersal of compressive stresses in struts of changing width shall be considered.

The angles between struts and ties in the selected truss model shall preferably be greater than 30 degrees and not less than 25 degrees.

Proportion nodal regions to satisfy the geometrical requirements of the nodal boundaries defined by adjacent struts, ties, reinforcing steel and/or bearings. See Figure IE 6.1.5.2.1I.2-1.

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restraint conditions by known reaction forces or vice versa. Strut-and-tie models can be made internally determinate by adding or removing struts.

Several reinforcement bars in the structure may be represented by a single tie in the strut-and-tie model.

Struts represent an idealization of the actual compressive stresses in the structure. At the location of concentrated forces compressive stresses will initially disperse laterally and at some distance from the node become parallel to the strut axis again, forming a bottle-shaped compressive stress field. This redirection of compressive stresses induces transverse tensile stresses. Bottle-shaped stress fields can be modeled using a local strut-and-tie model by splitting the single strut representing the bottle shaped strut into two sets of smaller struts which follow the deviation of the compression stress field.

More guidance for the proportioning of struts, and nodal region can be found in ACI Appendix A, and various industry publications.

References:

"Verification and Implementation of Strut-and Tie Model in LRFD Bridge Design Specifications," NCHRP report 20-07 (Task 217), Modjeki and Masters Inc., AASHTO 2007

"Toward a Consistent Design of Structural Concrete", Jorg Schlaich,

SPECIFICATIONS

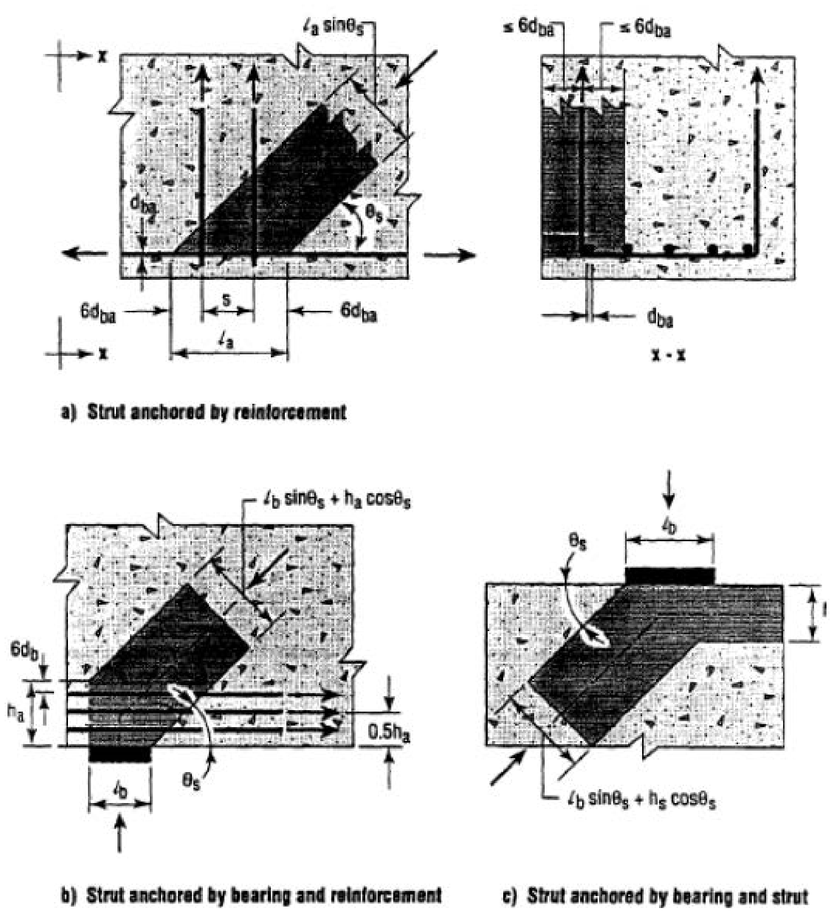

Figure IE 6.1.5.2.1I.2-1 Influence of Anchorage Conditions on Effective Cross-Sectional Area of Strut

STRENGTH REDUCTION FACTORS

The strength reduction factors (from AD 5.5.4.2) for strut-and-tie models shall be taken as follows:

Struts, $\phi = 0.70$

Ties, $\phi = 0.90$

Tie reinforcement must be fully developed at the inside corner of the node that the tie is connected to be completely effective.

STRENGTH OF TIES

The nominal strength of ties is given by:

$$P_n = f_y \cdot A_{st}$$

where: f_y = yield strength of the tie reinforcement

A_{st} = total area of the tie reinforcement considering the effects of deterioration

COMMENTARY

PCI Journal, May/June 1987, Vol 32, No 3,

Mitchell, Collins, Bhide, Rabbat, (2004) AASHTO LRFD Strut-and-Tie Model Design Examples, PCA

Reineck et al., (2002) Examples for the Design of Structural Concrete with Strut-and-Tie Models, ACI SP-208.

Hsu, Thomas T. C. (1993), Unified Theory of Reinforced Concrete, CRC Press: Boca Raton, Florida.

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STRENGTH OF STRUTS

Strut capacities are determined by the type of node a strut is connected to, the extent, width, and orientation of cracks crossing the strut, and a minimum amount of confinement reinforcement must be present to control such cracking.

The nominal strength of struts is given by:

$$P_n = f_{ce} \cdot A_{cs} + f_y \cdot A_{ss}$$

where: f_{ce} = effective concrete compressive strength

A_{cs} = cross-sectional area of strut considering the effects of Deterioration

f_y = yield strength of tie reinforcement

A_{ss} = area of reinforcement in the strut

The effective concrete compressive strength shall be taken as:

Struts
- prismatic struts without cracks = 0.85 f'c
- struts across cracks of normal width, if confining reinforcement is provided = 0.70 f'c
- struts across cracks of normal width, without confining reinforcement = 0.55 f'c
- struts in tension members and across wide cracks = 0.35 f'c

Nodes
- joining three struts (CCC node) = 0.85 f'c
- anchoring one tie (CCT node) = 0.75 f'c
- anchoring more than one tie (CTT node) = 0.65 f'c

LIMITING COMPRESSIVE STRENGTH IN STRUT

The limiting compressive stress, f_{cu} shall be taken as:

$$f_{cu} = \frac{f'_c}{0.8 + 170\ \varepsilon_1} \leq 0.85 f'_c$$

In which:

$$\varepsilon_1 = \varepsilon_s + (\varepsilon_s + 0.002)\cot^2 \alpha_s$$

where:

α_s = the smallest angle between the compressive strut and adjoining tension ties (°)

ε_s = the tensile strain in the concrete in the direction of the tension tie (in./in.)

f'_c = specified compressive strength (ksi)

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The effective concrete compressive strengths by strut type are based on ACI 318 19, Chapter 23, adjusted for the difference in the strength reduction factors for struts compared to AD. Alternatively, AD 5.6.3.3 may be used for determination of the compressive strengths of struts. The effective strengths of struts by node type are in accordance with AD 5.6.3.5.

If the concrete is not subjected to principal tensile strains greater than about 0.002, it can resist a compressive stress of 0.85 f'c. This will be the limit for regions of the struts not crossed by or joined to tension ties. The reinforcing bars of a tension tie are bonded to the surrounding concrete. If the reinforcing bars are to yield in tension, there should be significant tensile strains imposed on the concrete. As these tensile strains increase, f_{cu} decreases.

The expression for ε_1 is based on the assumption that the principal

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MINIMUM CONFINEMENT REINFORCEMENT

The minimum amount of confinement reinforcement required to prevent cracking shall meet the following:

$$\sum_i \rho_i \cdot \sin \alpha_i \geq 0.003$$

where: $\rho_i = \frac{A_{si}}{b_s \cdot s_i}$ = reinforcement ratio in direction i

A_{si} = reinforcement area in direction i
s_i = reinforcement spacing perpendicular to direction i
b_s = thickness of strut
α_i = angle between direction i and axis of strut

Minimum confinement reinforcement may be omitted only in massive concrete elements where reinforcing steel detailing has followed accepted practice or where uncontrolled cracking at a skew angle to the strut axis is unlikely. Refer to AD 5.8.2.6.

SERVICEABILITY

The strut-and-tie model developed for strength checks can be used to perform serviceability checks. Allowable stresses in reinforcing steel under service loads are listed in Table M 6B.5.2.3-1. For structures satisfying the strength requirements and minimum confinement reinforcement requirements stated above, allowable stresses under service loads may be increased to 60% and 75% of the yield strength at inventory and operating level, respectively, but not to exceed the values corresponding to Grade 60 reinforcing steel.

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compressive strain ε_2 in the direction of the strut equals 0.002 and that the tensile strain in the direction of the tension tie equals ε_s. As the angle between the strut-and-tie decreases, ε_1 increases and hence f_{cu} decreases. In the limit, no compressive stresses would be permitted in a strut that is superimposed on a tension tie, i.e., α_s=0, a situation that violates compatibility.

For a tension tie consisting of reinforcing bars, ε_s can be taken as 0.0 until the precompression of the concrete is overcome. For higher stresses, ε_s would equal $(f_{ps}-f_{pe})/Ep$.

If the strain ε_s varies over the width of the strut, it is appropriate to use the value at the centerline of the strut.

These minimum confinement reinforcement requirements follow those stipulated in ACI 318-05, which are more flexible than the corresponding specifications in AD. The strut-and-tie modeling approach relies on the capability of a reinforced concrete structure to redistribute internal forces with concrete cracking, yielding of reinforcement, and development of inelastic compressive strains in the concrete. This capability is greatly enhanced with the provision of minimum confinement reinforcement. Minimum confinement reinforcement is also essential to ensure ductile failure modes and to

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6.1.5.3I ADJACENT NON-COMPOSITE PRESTRESSED CONCRETE BOX BEAMS

Load ratings of adjacent non-composite prestressed concrete box beams with deterioration are to be based on one of the following procedures. The engineer shall determine the most suitable method for the bridge being analyzed. Method A is a conservative simplified method to determine the number of strands to remove for analysis. Method B is less conservative and more detailed than Method A and is based on Lehigh University's ATLSS 09-10 Study completed in 2010. Method C is special analysis of fascia beams required when the Capacity/Dead Load is < 1.5. The following procedures shall also be used to evaluate non-composite prestressed slab beam superstructures (plank beams). For an analysis example using Method A and Method B, see Appendix IE 04-D and the ATLSS 09-10 Study.

METHOD A – Simplified Method:

- Visually observed strands + 25% - Deduct 100% of all exposed strands plus an additional 25% (125% of the total area of the exposed strands) from capacity calculations. These strands shall be considered ineffective from the beam end to the location of the end of the spall. The strands shall be considered ineffective for the full beam length if the exposed strands are in the middle 1/3 of the span. Engineering judgement shall be used regarding the redevelopment of the strands.
- Strands adjacent to or intersecting a crack shall be considered ineffective in the region immediately adjacent to the crack.
- If significant strand loss is noted (>20%), especially for fascia beams, contact BDTD for further instructions.
- For beams with no exposed strands but which appear to have internal damage (as evidenced by bottom flange cracking with rust and/or delamination), contact BDTD for further instructions.
- For fascia beams with Capacity/Dead Load < 1.5, use Method C below.

METHOD B – Refined analysis based on ATLSS 09-10 Study:

Longitudinal Cracking:

1. The following strand areas shall be reduced to 75% of the original cross-sectional area within the analysis window for capacity calculations:
   a) Strands on each level directly in line with the crack
   b) Strands closest to the exterior surface adjacent to the longitudinal crack. If the adjacent strand is greater than 3" from the crack, see the following item for area reduction.
2. For beams with longitudinal cracking or corrosion induced spalling, all other strands in the section shall be reduced to 95% of the original cross-sectional area within the analysis window for capacity calculations.

Deteriorated Concrete:

1. For exposed strands observed with sound concrete adjacent to and above the exposed strands, disregard the full strength of the exposed strands within the analysis window for capacity calculations.

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control cracking under service loads.

IC6.1.5.3I Based on limited research of beams with longitudinal cracks in the bottom flange, the strand above the crack as well as the two adjacent lower layer strands may be deteriorating. For this condition, a parametric study of strand loss should be performed to determine the sensitivity of beam capacity to strand loss.

According to ATLSS Report No. 09-10 performed by Lehigh University in 2010, the factors that affect the beam capacity are longitudinal cracking and deteriorated concrete (including spalling and exposed reinforcement). These defects shall be accounted for in evaluation of the beam member.

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2. For exposed strands observed with adjacent unsound concrete, disregard the full strength of the exposed strands and all strands in regions of unsound concrete within the analysis window for capacity calculations.
3. For exposed shear reinforcement bars, disregard the full strength of strands located in the lower row directly above the exposed section of stirrups for capacity calculations. If the concrete is found to be unsound adjacent to the exposed area, disregard the strength of all strands in all rows above the area of unsound concrete within the analysis window for capacity calculations.
4. For area of concrete where delaminations have been observed, remove all delaminated concrete to determine the depth of the concrete deterioration:
   a) If shear reinforcement bars or strands are exposed, treat as in cases "1" through "3" as shown above.
   b) If no shear reinforcement bars or strands are exposed but there are indications that the exposed concrete is unsound within the effected area, disregard the strength of all strands located in the rows of strands above the area within the analysis window for capacity calculations.
   c) If no steel reinforcement is exposed in the affected area and the concrete is deemed as sound, do not disregard the strength of strands within the analysis window in capacity calculations.
5. For wet or stained areas of concrete observed on the bottom or side of beams, closely inspect those areas to determine the soundness of concrete:
   a) If close inspection indicates that the concrete is unsound or delaminated, treat as in case "4" above.
   b) If close inspection confirms that the concrete is sound, do not disregard the strength of strands within the analysis window in the capacity calculations.
6. For fascia beams with Capacity/Dead Load < 1.5, use Method C below.

For the purpose of load rating, all damage within a region of two development lengths shall be considered to occur at the same analysis window. The computed development length can be used; however, if design information is unavailable the lengths presented in Table IE 6.1.5.3I-1 can be used for typical seven wire strands:

Table IE 6.1.5.3I-1: Analysis Window Length Based on Strand Diameter

Strand Nominal Diameter (in)	Analysis Window Length (in)
3/8	128
7/16	150
1/2	170
½ Special	180

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METHOD C – Special Analysis of Fascia Beams

- Because the live load portion of the total load carried by fascia beams is small, the load rating may be > 1.0 and not reflect the marginal capacity above dead load. Thus, when Capacity/Dead Load is < 1.5, a more detailed analysis is required. For fascia beams with Capacity/Dead Load < 1.5 or an Operating Rating < 1.5 based on a conventional analysis, an analysis that considers biaxial stresses will be performed by BDTD.

6.1.6 Evaluation of Complex Structures

The following shall supplement M 6.1.6.

Additional requirements for PA bridges are contained in IP 3.3.3. and IP 3.3.4.

6.1.9 Documentation of Rating

The following shall supplement M 6.1.9.

Additional Requirements for PA bridges are contained in IP 8.3.2.

PART A – LOAD AND RESISTANCE FACTOR RATING

6A.1 INTRODUCTION

The following shall supplement M 6A.1.

LRFR method as outlined in the MBE Section 6A may be used on PA bridges when it is warranted, however, prior approval of the Bridge Inspection Section Chief is required. See IP 3.6 for guidance on the use of LRFR ratings.

PART B – ALLOWABLE STRESS RATING AND LOAD FACTOR RATING

6B.1 GENERAL

The following shall supplement M 6B.1.

Additional requirements for PA bridges are contained in IP 3.

6B.3 RATING METHODS

The following shall supplement M 6B.3.

For live load capacity rating methods for PA bridges see IP 3.6.

6B.5 NOMINAL CAPACITY: C

6B.5.2 Allowable Stress Method

6B.5.2.1 STRUCTURAL STEEL

The following shall replace the first sentence of M 6B.5.2.1.

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The allowable unit stresses used for determining the Inventory Ratings and Operating Ratings depend on the type of steel used in the structural members.

The following shall replace the formula for compression in concentrically loaded columns in Table M 6B.5.2.1.

With $C_c = \sqrt{2\pi^2 E/Fy}$

$F_a = F_y/F.S.\left[1 - \left[\left[(KL/r)^2 F_y\right] / 4\pi^2 E\right]\right]$ when $KL/r \le C_c$

$F_a = \pi^2 E / \left[F.S.(KL/r)^2\right] = 168{,}363{,}840 / (KL/r)^2$ when $KL/r > C_c$

With F.S. = 1.70

6B.5.2.1.1 Combined Stresses

The following shall supplement M 6B.5.2.1.1.

When performing compression member analyses, and in particular of lightly constructed, built-up compression truss member end posts that are unsymmetrical, the pin eccentricity (i.e. the distance between the centerline of pin and the neutral axis of member) must be evaluated.

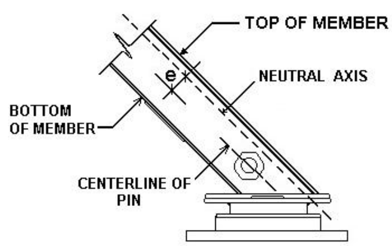

Figure IE 6B.5.2.1.1-1

6B.5.2.1.3I Gusset Plates in Truss Bridges

See MBE Appendix L6A for analysis of gusset plates in truss bridges.

6B.6 LOADINGS

The following shall supplement M 6B.6.

Additional requirements for PA bridges are contained in IP 3.2.

6B.6.1 Dead Load: D

The following shall supplement the second paragraph of M 6B.6.1.

COMMENTARY

IC6B5.2.1 Safe Load Capacity is discussed under bridge postings, IP 4.3.2.

IC6B5.2.1.1 For the case shown in Figure IE 6B.5.2.1.1-1 the bottom flange is more critical, therefore $f_{bx} = Pe/S_{bottom}$ when determining combined stresses as per M 6B.5.2.1.1.

In the event of significant damage (buckled lacing and/or sheared rivets/bolts caused by impact) to the end posts of the truss, considerations shall be made to reduce the members capacity. The amount of reduction should be evaluated on a case by case basis, utilizing engineering judgment based on the type and amount of damage to the member element.

SPECIFICATIONS

For encased I-beam (EIB) bridge analyses, the following criteria will determine whether the composite or non-composite section carries the superimposed dead load and live load:

- If the structure was built using shored construction, the composite section may be used to carry the superimposed dead load and the live load.
- If the structure was built using unshored construction, the non-composite section is to be used to carry the superimposed dead load and the live load.
- If the Deck or Superstructure (BMS2 Item 1A01 or 1A04) is in poor condition, the non-composite section is to be used to carry the superimposed dead load and the live load regardless of the construction method used to build the structure.

The following shall supplement M 6B.6.1.

For adjacent non-composite prestressed concrete box beams, the following criteria shall be used to determine the distribution of barrier dead loads:

- Assume fascia beams support 100% of the barrier dead load.
- Assume the first interior beams support 50% of the barrier dead load.

6B.6.2 Rating Live Load

The following shall supplement M 6B.6.2.

Additional requirements for PA bridges are contained in IP 3.2.2.

6B.6.3 Distribution of Loads

The following shall supplement M 6B.6.3.

For adjacent non-composite prestressed concrete box beams, the following criteria shall be used to determine the distribution of live loads for moment and shear:

- Fascia girder shall use the larger of the LFD Distribution Factor (IP 3.3.2.2) or Lever Rule (AD 4.6.2.2).
- Interior girder shall use a wheel load distribution factor = 1.0 where there is a loss of grout in the shear key and/or tie rod.

6B.6.7 Environmental Loads

6B.6.7.4 STREAM FLOW

The following shall replace the second sentence of M 6B.6.7.4.

However, remedial action should be considered if these forces are especially critical to the structure's stability.

6B.6.7.5 ICE PRESSURE

The following shall replace the second sentence of M 6B.6.7.5.

COMMENTARY

IC6B.6.1. See BAR7 computer program documentation for discussion regarding EIB beams and their analysis.

SPECIFICATIONS COMMENTARY

If these forces are especially important, then corrective action should be recommended.

6B.7 POSTING OF BRIDGES

The following shall replace M 6B.7.

Requirements for posting of PA Bridges are contained in IP 4.

6B.7.1 General

Delete the third paragraph of M 6B.7.1.

6B.8 PERMITS

The following shall replace M 6B.8.

Requirements for PA permitting are contained in IP 10.

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SPECIFICATIONS COMMENTARY

The following shall replace M 7.

7.1I GENERAL

For PA bridges see DM4 PP 5.1 and PD 6.6.1.

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SPECIFICATIONS COMMENTARY

The following shall replace M 8.

8.1I BRIDGE INSTRUMENTATION INTRODUCTION

The purpose of instrumentation and monitoring of a bridge is to diagnose a known deficiency and to develop retrofit details to correct the deficiency. The diagnostic testing shall include both the static and dynamic response of the bridge. The diagnostic testing must be implemented in accordance with a pre-defined test program including objectives and a detailed instrumentation plan. Typically, instrumentation and monitoring has been used to perform fatigue evaluation of steel bridges for the purpose of estimating remaining fatigue life and developing retrofit concepts.

The instrumentation and monitoring of a bridge shall not be used to determine the load carrying capacity or load posting unless otherwise approved by the Chief Bridge Engineer. The bridge load carrying capacity predicted from field load testing is affected by several factors such as:

- unintended composite action
- unintended continuity or bearing fixity
- participation of secondary members
- participation of nonstructural members
- portion of load carried by deck

These factors tend to influence test results by indicating lower live load stresses than calculated stresses, and thus predict a higher load carrying capacity at service load levels. The enhanced behavior due to unintended participation may not be present at load levels higher than the test load. At the higher load levels, the loss of unintended participation will result in increased stresses in main members. Therefore, the extrapolation of test results to determine the load carrying capacity at load levels in excess of the tested live loads is not permitted.

8.2I CONTRACTING PROCEDURES

The instrumentation and monitoring of bridges is a professional service. Companies that intend to provide these services must be a registered business partner with a relationship type classification of consultant in the Department's Engineering and Construction Management System (ECMS). In addition to registering as a business partner, the company must have an active consultant qualification package, an approved overhead rate, and an employee roster in ECMS.

Companies intending to provide testing services must have a demonstrated record of performing such work, including both the physical installation of monitoring systems as well as the interpretation of the data.

Typically, this service is one of many tasks within a contract, and therefore bridge testing service is performed by a sub-consultant on behalf of the prime consultant.

SPECIFICATIONS COMMENTARY

8.3I INSTRUMENTATION

The instrumentation used for diagnostic bridge testing may include:

- Strain gages or other types of strain transducers
- Displacement transducers
- Rotation gages
- Accelerometers

The instrumentation must be connected to a data acquisition system that is capable of capturing and storing response data for processing of the results to fulfill the objectives of the testing program. Specifically, data must be sampled at a rate high enough to ensure that the peak response of a given bridge element is captured. Moreover, the data acquisition system must have sufficiently high resolution to ensure that the complete response of a given bridge element is measured.

For fatigue evaluations, the data acquisition must be capable of performing cycle counting using the rainflow cycle-counting algorithm. This algorithm is used to develop the measured stress-range histograms at strain gauge locations.

8.4I DIAGNOSTIC TEST PROGRAM

A diagnostic testing program shall be developed prior to the field instrumentation and monitoring of a bridge. The program shall include the test objectives, level of structural analysis to be performed prior to and after field testing, types and layout of instrumentation, the test load to be used, field testing procedures, expected duration and requirements for maintenance and protection of traffic, as well as evaluation methodology of test data and reporting.

The test load may consist of controlled vehicles of known weight and/or the regular traffic on the bridge. Using controlled vehicles of known weight traveling at known locations provides data to correlate the responses of all sensors with a known load. The controlled test, when running test vehicles along the same positions at crawl and full speeds, also allows assessing the effects of dynamic impact.

8.5I EVALUATION OF INSTRUMENTATION RESULTS

The test results shall be evaluated in such a manner to satisfy the objectives set in the test program. The results of the instrumentation should be compared to analytical predictions to demonstrate the validity of the tests. A comparison of static and dynamic measurements shall be performed to assess the dynamic amplification effects. In addition, a determination of live load distribution factor shall be performed. The calculated live load distribution shall be compared to values predicted from the AASHTO LRFD Bridge Design Specifications.

For fatigue testing results, measured stress range histograms shall be reduced and compared to the S-N fatigue curves in the AASHTO-LRFD Bridge Design Specifications.

SPECIFICATIONS

8.6I REPORTING

A comprehensive report shall be prepared describing the general features of the bridge, the objectives of the testing program, description of the testing procedures, instrumentation plan, instrumentation results, interpretation of the instrumentation results, and comparison of results with numerical analysis, as well as the evaluation of the results per Section 5.5I for dynamic amplification effects and live load distribution. The objective of the instrumentation and monitoring is to correct a known deficiency, thus the report must include recommendations and retrofit concepts.

The report shall include an executive summary, photographs of the instrumentation, and graphical and tabular presentation of results. The report shall be signed and sealed by a Professional Engineer Registered in the Commonwealth of Pennsylvania.

8.7I INSTRUMENTATION SYSTEMS

The most common method of determining the behavior of a bridge is through instrumentation with strain gages/transducers and displacement measuring devices. The use of strain and displacement measuring devices has proven history of providing reliable results that fulfill the objective of most bridge testing programs.

As technology continues to evolve, additional types of sensors, instrumentation devices, or wireless or remote monitoring systems (both in terms of sensors and data acquisition systems) have been developed or are still being developed. New instrumentation systems that have not been used by the Department shall be evaluated for proof of concept. The proof of concept evaluation may occur by:

- Concerted research project conducted by the Department
Success performance and favorable evaluation of the system by another Department of Transportation or governmental agency

COMMENTARY

IC5.7I Two different monitoring sensors have been tested through Research Project No.: 3900017209, titled "Remote Health Monitoring and Load Modeling of Cracked Fracture Critical Bridge Components". LifeSpan Technologies' Model LST Structural Health Sensor (LST) and Matech Material Technologies' Electrochemical Fatigue Sensor (EFS) systems.

A third project, Contract No 4400017287, 3515R08 "Instrumentation & Monitoring of PA Bridges." The contract duration is 2017 thru 2021 and the instrumentation that is being evaluated under this contract is by Resensys.

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Appendices for Chapter IE 04 Inspection

IE 04-A Truss Inspection Findings Summary

IE 04-B Rocker Bearing Movement Analysis Guidelines and Procedures

IE 04-C Adjacent Non-Composite P/S Concrete Box Beam Inspection Forms

IE 04-D Adjacent Non-Composite P/S Concrete Box Beam Analysis Example

IE 04-E Corrugated Metal Culvert Inspection Forms

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APPENDIX IE 04-A

Truss Inspection
Findings Summary

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BMS ID: ______________________________

Insp. Date: ______________________________

Insp. By: ______________________________

Checked By: ____________________________

Date: ____________________________

Truss Inspection Findings Summary
Truss Members and Floorbeam Ends

Span	Truss Line	Member	FCM (Y/N)	Member Cond. Rating (0-9)	Crack? (Y/N)	Crack Retrofitted (Y/N)	Section Loss (Y/N)	Tack Welds Present (Y/N)	Tack Welds Cracked (Y/N)	NDE Test Recommended (Y/N)	Photo No.'s	Sketch No.'s	Comments

BMS ID: ______________________ Checked By: ______________________

Insp. Date: ______________________ Date: ______________________

Insp. By: ______________________

Truss Inspection Findings Summary
Panel Point Connection Condition
(includes truss member and bracing connections)

Panel Point	Truss Line	Section Loss (Y/N)	Weld Cracks (Y/N/NA)	Crack Retrofit (Y/N/NA)	NDE Test Recommended (Y/N)	Missing Bolts (Y/N/NA)	Loose Bolts (Y/N/NA)	Photo No.'s	Comments

BMS ID: ______________________ Checked By: ______________________

Insp. Date: ______________________ Date: ______________________

Insp. By: ______________________

Truss Inspection Findings Summary
Bearing Condition

Sub Unit	Truss Line	Type	Fixed/Exp (F or E)	Frozen (Y/N/NA)	Over Extended (Y/N/NA)	Photo No.'s	Comments

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APPENDIX IE 04-B

Rocker Bearing Movement Analysis
Guidelines and Procedures

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Publication 238 (2021 Edition), Appendix IE 04-B
Rocker Bearing Movement Analysis Guidelines and Procedures

The following documentation is required for each location where rocker bearings are present. This information shall be collected from the most distressed bearing on each bearing line at a substructure unit for every inspection cycle. In the case of a single pier with two lines of expansion rocker type bearings supporting two different spans, two worst case bearings will be recorded, one for each bearing line. For bearing lines where more than one bearing appears to be distressed, also record information/documentation for these bearings.

The following procedure shall be used to assess the condition and movement of rocker bearings:

1. Enter the input data on the Rocker Bearing Movement Analysis spreadsheet (Location data, substructure type(Abutment or Pier), radius of rocker plate(R), width of rocker plate(D), and expansion Length(L) from existing plans or field measurements. See Figure 4-B-2 for a sample of the spreadsheet. The spreadsheet will calculate the allowable tilt limits in as outlined in Table 4-B-1. Complete this procedure prior to the inspection.
2. During the inspection, measure the ambient temperature, angle of rotation(θ), and minimum clearance between girders or from girder to abutment(X). Also, confirm the radius of rocker plate(R) and width of rocker plate(D).
3. Compare the field measured rocker tilt to the table of allowable tilt range to determine if a Priority 0 or 1 maintenance item is required based on the current ambient temperature.
4. Input the rotation measurements into the spreadsheet. The spreadsheet will determine the appropriate maintenance priority based on tilt measurement only, in accordance with Pub 100A, based on the current measurements at the ambient temperature. Consider adjusting maintenance priority based on ADT of the bridge, feature under the bridge, flexibility of the substructure, condition of the bearings, number of bearings in a line with excessive tilt, type of superstructure, structural redundancy, ability of the bearing to freely move, and evidence of pintel failure.
5. Upload the final spreadsheet to Inventory section under Documents in BMS2.
6. Attach a printout of the Rocker Bearing Movement Analysis to the current inspection report.

In addition to the procedure above, the inspection report shall include the following guidance for reporting rocker bearing condition and functionality:

- Use language, “expanded” or “contracted”, do not use terms such as “back” or “North”.
- Note whether the bearing shows signs of movement (indicated by cracks in the paint at locations of intended movement between bearing components, polished metal at bearing surfaces, or light colored rust powder created by movement) or if the bearing has sufficient capacity to move further in the direction of travel under temperature extremes.
- Presence of corrosion, including pack rust or any debris under the rocker that could inhibit proper bearing function and freedom of movement.
- Flattened bearing surfaces.
- Section loss to any portion of the bearing assembly including anchor bolts.
- Location of sheared off or bent anchor bolts where applicable.
- Evidence of sheared pintels.
- Evidence of masonry plate movement.
- Cracks in concrete seats.
- Abnormal or unusual gap measurements at deck expansion joints.

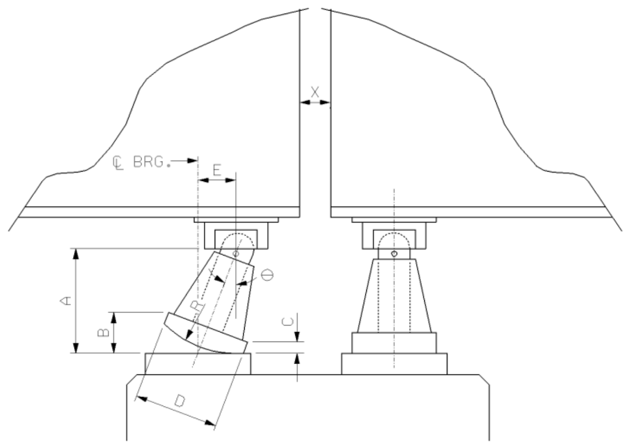


Figure 4-B-1 Rocker Bearing Field Documentation Reference Sketch

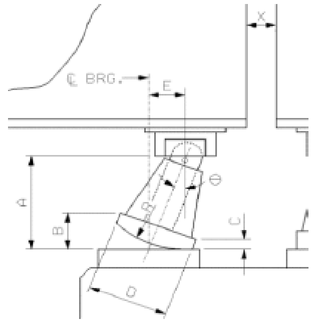
Notation:

A = as-inspected height of rocker (in.)
B = high corner of rocker plate (in.)
C = low corner of rocker plate (in.)
D = width of rocker plate (in.)
E = longitudinal translation (in.)
R = radius of rocker plate (in.)
X = minimum clear distance between girders or from girder to abutment (in.)
θ = angle of rotation (tilt) (degrees)

Figure 4-B-2 Sample Rocker Bearing Movement Analysis
This spreadsheet can be downloaded from the BMS2 Home Screen

ROCKER BEARING TILT DIMENSION DATA

Date:	4/18/2019	
Ambient Temperature:	58	°F
Expansion Length (L):	230	ft
Radius (R):	10	in
Plate Width (D):	7	in
Coeff. of Thermal Exp.:	6.50E-06	per °F
Min Clearance (X):	2	per °F



Inspectors:	
BMS #:	XX-XXXX-XXXX-XXXX
BRKEY:	XXXXX
Bridge Location:	SR xx over Unkown Creek
Rocker Line:	P02a
Support Type:	Pier

Rocker Line:	P02a	P02a	P02a	P02a	P02a	P02a	P02a	P02a	P02a	P02a	P02a	P02a
Beam:	1	2	3	4	5	6	7	8	9	10	11	12
$\theta_{Field\ Measured}$:	-1.7	-11.0	-4.0	-3.0	-1.2	-0.4	-0.2	0.0	1.0	4.0	5.0	6.0
Temperature:	58	58	58	58	58	58	58	58	58	58	58	58
$E_{From,68°F}$:	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18
$\theta_{From,68°F}$:	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
E min:	-0.53	-0.53	-0.53	-0.53	-0.53	-0.53	-0.53	-0.53	-0.53	-0.53	-0.53	-0.53
θ min:	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0
E max:	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82
θ max:	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
Capacity:	35%	N/A	150%	100%	10%	11%	14%	18%	35%	88%	105%	123%
Priority:	OK	PR0	PR1	PR3	OK	OK	OK	OK	PR3	PR3	PR1	PR1
Comments:	Provide notes as need (i.e. justification of maintenance priority or reason for priority different from above, pack rust, debris restriction, frozen bearings, evidence of pintel failure, etc.)											

Past Rocker Bearing Tilt Dimension Data

Rocker Line:		P02a	P02a	P02a	P02a	P02a	P02a	P02a	P02a	P02a	P02a	P02a	P02a
Beam:		1	2	3	4	5	6	7	8	9	10	11	12
Date	°F												
4/1/2013	35	0.6	0	-2	-1	-0.8	-0.9	6	1	4.7	3.1	2.6	3.4
4/27/2015	55	-1.8	-1.9	-0.7	-1.5	-1.8	-1.3	-1.1	-1.3	-0.4	-0.4	-1.3	-1
4/1/2017	62	-1.2	-1.5	1.1	-1.5	-1.9	-1.2	-0.8	-1.3	2	-1.7	-1.3	-0.8
4/18/2019	58	-1.7	-7.5	-4.2	-3	-1.2							
4/19/2019	72						-0.4	-0.2	0	0.1	4	7.1	7.2

Table 4-B-1 Acceptable Range of Tilt Angles, θ_{min} and θ_{max}
Table to be completed prior to inspection using procedure described herein. The Rocker Bearing Movement Analysis spreadsheet can be utilized to complete this table (The spreadsheet is available for download from the BMS2 Home screen). This table provides the maximum and minimum allowable tilts for any given ambient temperature. The inspector should use these tilt angle ranges in the field as a guide to determine if the bearing tilt is within acceptable limits. The acceptable limit of tilt at piers is the outer one-quarter point of the rocker plate. The acceptable limit of tilt at abutments is the outer one-tenth point of the rocker plate. If design plan bearing dimensions are used to generate table, they should be verified by field measurement.

Temp. (°F)	-10	0	10	20	30	40	50	60	68	70	80	90	100	110
θ_{min} (deg)														
θ_{max} (deg)														
E_{min}														
E_{max}														

Notes:
1) A negative tilt angle denotes contraction (movement towards the fixed bearing) and a positive tilt angle denotes expansion (movement away from the fixed bearing).
2) The longitudinal bridge movement described herein includes thermal movement only.

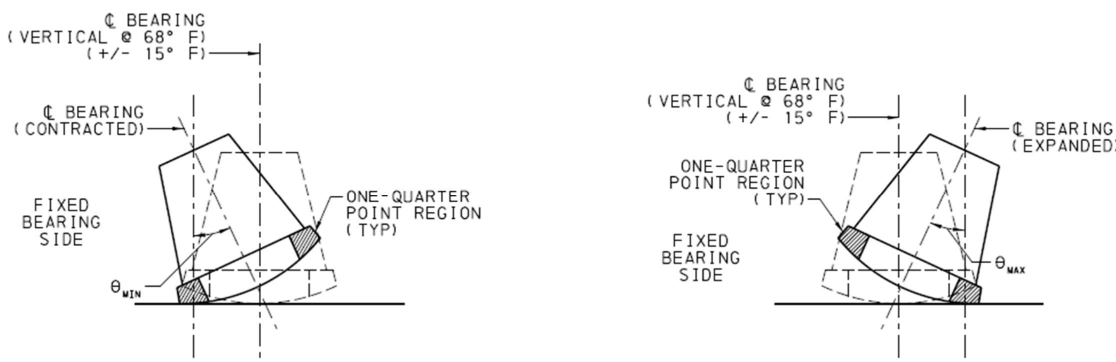


Figure 4-B-3 Rocker Bearing Tilt Angle Reference Sketch

Procedure to calculate θ_{min} and θ_{max}

The following procedure is used to determine the acceptable tilt angle range (θ_{min} to θ_{max}) in Table 4-B-1. Either the one-quarter or the one-tenth point can be determined with this methodology.

Required information:

rocker plate width, D (in.)
rocker plate radius, R (in.)
coefficient of thermal expansion, α (6.5 x 10^{-6}/ºF for steel)
expansion length, L (ft.)

Step 1: Determine the one-quarter point dimension for rocker bearings at piers, 0.25D; this is the maximum allowable movement in one direction. Determine the one-tenth point dimension for rocker bearings at an abutment, 0.4D; this is the maximum allowable movement in one direction.

Step 2: Calculate the movement increment for the 10° F intervals shown in Table 4-B-1.

Step 3: For θ_{min}, set the maximum allowable thermal movement to -0.25D (-0.4D) (contracted) at -10° F and add the movement increment calculated in Step 2 at each 10° F increment to obtain the adjusted thermal movement, d_{adj}, for θ_{min}. Contraction movement is shown as a negative value.

Step 4: For θ_{max}, set the maximum allowable thermal movement to 0.25D (0.4D) (expanded) at 110° F and subtract the movement increment calculated in Step 2 at each 10° F increment to obtain the adjusted thermal movement, d_{adj}, for θ_{max}. Expansion movement is shown as a positive value.

Step 5: Determine the subsequent tilt angles, θ_{min} and θ_{max}, for use in Table 4-B-1.

$$\theta_{min/max} = \sin^{-1}[d_{adj} / SQRT(R^2 + d_{adj}^2)] (180 / \pi)$$

Note: if d_{adj} is the contracted movement, then θ is taken as the negative of this expression in order to be consistent with the sign convention described in Steps 3 and 4. No change in sign is required if d_{adj} is the expanded movement.

Sample calculation for θ_{min} and θ_{max}

Required information:

D = 7 in.
R = 10 in.
α = 6.5 x 10^{-6} /°F (for steel)
L = 230 ft.

Step1 (Calculation of maximum allowable movement):
Determine the one-quarter (one-tenth) point dimension. The maximum allowable movement in either the expanded or contracted direction is taken equal to one-quarter of the rocker plate width.

0.25D = 1.75 in. (0.4D = 2.80 in.)

Step 2 (Calculate the movement increment):

E = Structure thermal movement (in.) Note: contraction movement is taken as negative and expansion movement is taken as positive.

= $12\alpha L\Delta_t$

where:

Δ_t = Temperature change with respect to 68° F

and

$d_{inc} = E_{Thigh} - E_{Tlow}$ = movement increment (in.)

	Str. Thermal Movement	Movement Increment (d_{inc})	
At -10° F	$E_{From,68^oF}$ = -1.40 in.		
At 0° F	$E_{From,68^oF}$ = -1.22 in.	$d_0 - d_{-10}$ =	0.18 in.
At 10° F	$E_{From,68^oF}$ = -1.04 in.	$d_{10} - d_0$ =	0.18 in.
	etc.		etc.

The only non-uniform increment will occur at the 68° F interval.

	Thermal Movement		Movement Increment (d_{inc})
At 60° F	d_{60} =	-0.14 in.	
At 68° F	d_{68} =	0 in.	$d_{68} - d_{60}$ = 0.14 in.
At 70° F	d_{70} =	0.04 in.	$d_{70} - d_{68}$ = 0.04 in.

Step 3 (Calculation of E_{min}):

For θ_{min}, set the movement at -10° F equal to -0.25D (-0.4D). Add the movement increment(d_{inc}) to calculate E_{min} for the next temperature increment.

At -10° F   Set -> E_{min} = -1.75 in. (-2.80 in.)

At 0° F E_{min} = -1.75 + 0.18 = -1.57 in. (-2.80 + 0.18 = -2.62 in.)

At 10° F E_{min} = -1.57 + 0.18 = -1.39 in. (-2.62 + 0.18 = -2.44 in.)

:

:

At 110° F E_{min} = 0.22 + 0.18 = 0.40 in. (-0.82 + 0.18 = -0.64 in.)

Step 4 (Calculation of E_{max}):

For θ_{max}, set the movement at 110° F equal to 0.25D (0.4D). Subtract the movement increment(d_{inc}) to calculate E_{min} for the next temperature increment.

At -10° F E_{max} = -0.22 – 0.18 = -0.40 in. (0.82 - 0.18 = 0.64)

:

:

At 90° F E_{max} = 1.57 – 0.18 = 1.39 in. (2.62 – 0.18 = 2.44 in.)

At 100° F E_{max} = 1.75 – 0.18 = 1.57 in. (2.80 – 0.18 = 2.62 in.)

At 110° F   Set -> E_{max} = 1.75 in. (2.80 in.)

Step 5 (Calculation of $\theta_{min/max}$):

The tilt angles are determined using the adjusted thermal movement and rocker plate radius. Round the tilt angle to the next largest integer.

$$\theta_{min/max} = \sin^{-1}[E_{min/max} / SQRT(R^2 + E_{min/max}{}^2)]\ (180 / \pi)$$

Minimum Tilt Angle (θ_{min})

At -10° F θ_{min} = -10 deg (-16 deg)
At 0° F θ_{min} = -9 deg (-15 deg)
At 10° F θ_{min} = -8 deg (-14 deg)
:
:
At 110° F θ_{min} = 3 deg (-4 deg)

Maximum Tilt Angle (θ_{max})

At -10° F θ_{max} = -3 deg (4 deg)
:
:
At 90° F θ_{max} = 8 deg (14 deg)
At 100° F θ_{max} = 9 deg (15 deg)
At 110° F θ_{max} = 10 deg (16 deg)

Therefore, Table 4-B-1 can be completed with the calculated values for the given bearing information. This table provides the maximum and minimum allowable tilts for any given ambient temperature for an observed rocker bearing. The inspector should use these tilt angle ranges as a guide to determine if the bearing tilt is within acceptable limits (i.e. at no point during thermal expansion and contraction of the bridge will the rocker bear on the outer one-quarter point of the rocker plate at a Pier or the outer one-tenth point of the rocker plate at an Abutment).

Temp. (°F)	-10	0	10	20	30	40	50	60	68	70	80	90	100	110
θ_{min} (deg)	-10	-9	-8	-7	-6	-5	-4	-3	-3	-2	-1	1	2	3
θ_{max} (deg)	-3	-2	-1	1	2	3	4	5	6	6	7	8	9	10

Notes:
1) A negative tilt angle denotes contraction (movement towards the fixed bearing), a positive tilt angle denotes expansion (movement away from the fixed bearing).
2) The longitudinal bridge movement described herein includes thermal movement only.
3) Equation assumes lower rocker bearing surface is circular with its center located at the center of the upper semicircular bearing surface.
4) The table can also be completed with the E_{min} and E_{max} rows.

Procedure to calculate the Capacity of a Rocker Bearing

The following procedure is used to determine the Capacity of a rocker bearing (% of maximum capacity based on the current measurement at ambient temperature).

Capacity (when contracted from neutral) = $[\theta_{Field\ Measured} - \theta_{From,68°F}] / [\theta_{min} - \theta_{From,68°F}]$

Capacity (when expanded from neutral) = $[\theta_{Field\ Measured} - \theta_{From,68°F}] / [\theta_{max} - \theta_{From,68°F}]$

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APPENDIX IE 04-C

Adjacent Non-Composite P/S Concrete Box Beam Inspection Forms

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ADJACENT NON-COMPOSITE P/S BOX BEAM INSPECTION FORM

District: ______________ Inspected by: ______________

BMS #: ______________________________ Inspection Date: ______________

6B40 **Wearing Surface Condition:** ☐

5B02 - 5B04 **Wearing Surface Type:** ☐☐☐

1A04 **Superstructure Condition:** ☐

STRAND CONDITION DATA:

of pre-stressing strands that are exposed:____ Beam #____ Span #____ Location* ______________
____ Beam #____ Span #____ Location* ______________
____ Beam #____ Span #____ Location* ______________
____ Beam #____ Span #____ Location* ______________
____ Beam #____ Span #____ Location* ______________

# of pre-stressing strands that are cut: ____ Beam #____ Span #____ Location* ______________
____ Beam #____ Span #____ Location* ______________
____ Beam #____ Span #____ Location* ______________
____ Beam #____ Span #____ Location* ______________
____ Beam #____ Span #____ Location* ______________

*Location of exposed/cut strands is the distance from centerline of near bearing to c.g. of cut/exposed strands

Strand Notes: ____

ADJACENT NON-COMPOSITE P/S BOX BEAM INSPECTION FORM

District: ______________ Inspected by: ______________

BMS #: ______________________________ Inspection Date: ______________

BEAM CONDITION DATA:

Is moisture or moisture staining present at longitudinal beam joints? Yes ☐ No ☐
If yes, describe the location including which beams and span #:

____
____
____

Transverse Cracks: Yes ☐ No ☐
If yes, describe the quantity, location (including beam # and span #), size, and any evidence of rust staining:

____
____
____

Longitudinal Cracks Yes ☐ No ☐
If yes, describe the quantity, location (including beam # and span #), size, and any evidence of rust staining:

____
____
____

Spalls: Yes ☐ No ☐
If yes, describe the quantity, location (including beam # and span #), size, and any evidence of rust staining:

____
____
____

Delaminations: Yes ☐ No ☐
If yes, describe the quantity, location (including beam # and span #), size, and any evidence of rust staining:

____
____
____

Post Tensioning: Yes ☐ No ☐
If yes, describe the quantity, location, and condition (rust staining, grout, and effectiveness):

____
____
____

Evidence of Shear Key Failure: Yes ☐ No ☐
If yes, describe the condition (including leaking at joints, reflective cracking in the wearing surface above the beam joints, and relative displacement between beams.):

____
____
____

ADJACENT NON-COMPOSITE P/S BOX BEAM INSPECTION FORM

District: ________________ Inspected by: ________________

BMS #: ________________________________ Inspection Date: ________________

Provide sketch of beam(s) and deficiencies (leakage, efflorescence, cracks, delamination, spalls, exposed and broken P/S strands):

Span: ___

BEAM		1/3 Pt →		2/3 Pt →		
NEAR SUBSTRUCTURE	#1					FAR SUBSTRUCTURE
	#2					
	#3					
	#4					
	#5					
	#6					
	#7					
	#8					
	#9					
	#10					
	#11					
	#12					

ADJACENT NON-COMPOSITE P/S BOX BEAM INSPECTION FORM

District: ______________ Inspected by: ______________

BMS #: ______________________________ Inspection Date: ______________

PARAPET DATA:

Left Parapet

Does the parapet have an open joint? Yes ☐ No ☐

Do any parapet joints exhibit any signs of leakage? Yes ☐ No ☐

Does the beam around the joint exhibit cracking? Yes ☐ No ☐

What is the distance between the open parapet joint and the nearest spall in the beam? ______________

Describe the locations and conditions in the notes below:

____

____

____

____

____

____

Right Parapet

Does the parapet have an open joint? Yes ☐ No ☐

Do any parapet joints exhibit any signs of leakage? Yes ☐ No ☐

Does the beam around the joint exhibit cracking? Yes ☐ No ☐

What is the distance between the open parapet joint and the nearest spall in the beam? ______________

Describe the locations and conditions in the notes below:

____

____

____

____

____

____

ADJACENT NON-COMPOSITE P/S BOX BEAM INSPECTION FORM

District: ________________ Inspected by: ________________

BMS #: ________________ Inspection Date: ________________

SUPPLEMENTAL INSPECTION NOTES:

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APPENDIX IE 04-D

Adjacent Non-Composite P/S Concrete
Box Beam Analysis Example

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Adjacent Non-Composite P/S Concrete Box Beam Analysis Example

A prestressed concrete box beam section is illustrated in Figure 1. The damage within a region of analysis window (as determined by Table 6B.5.3.3.1-1I) is included in the section image and occurs within the middle 1/3 of the span. Field inspection of the beam identified three longitudinal cracks, spalling, and an area of unsound concrete. The construction documentation indicates that the beam is reinforced with 36 – 3/8 in. diameter seven-wire grade 270 prestressing strands. The spacing and arrangement of the strands is shown in Figure 1.

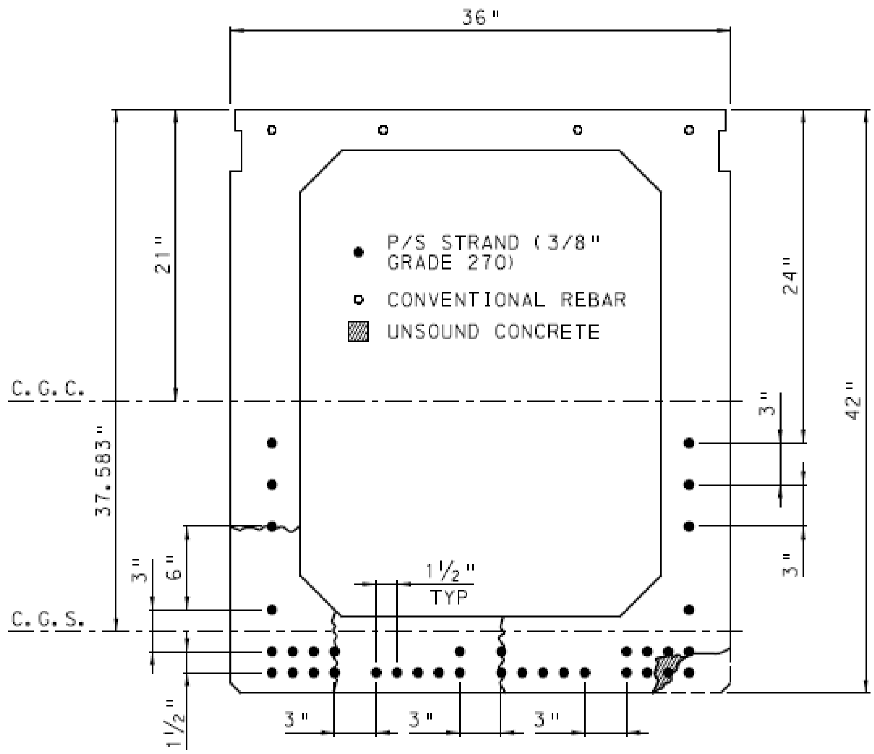

Figure 1 – Original Beam with Deterioration

Original Beam			
Row	# Strands	Dist from Bot of Beam (d_b)	# Strands x d_b
1	18	1.5"	27.0"
2	10	3.0"	30.0"
3	2	6.0"	12.0"
4	2	12.0"	24.0"
5	2	15.0"	30.0"
6	2	18.0"	36.0"
		C.G.S. =	**4.417"**
		Strand Area =	**0.085 in^2**
		# Strands =	**36**

Table 1: Strand Layout and CGS of Original Beam

Bridge Rating Evaluation Example using Method A:

Using Method A, a total of 12 strands would be removed from the analysis. Because the deterioration occurs in the middle 1/3 of the span, these strands are removed for the entire length of the beam. The strands above each crack in both rows are removed, as well as strands immediately adjacent to each crack in the bottom row. The strand adjacent to the crack on the side of the beam in addition to the crack 3" above this crack have been removed (Assume the strand 6" below is not affected). The strand exposed by the spall has been removed and the strand located in the delaminated concrete has been removed. The final strand pattern used for analysis is shown in Figure 2.

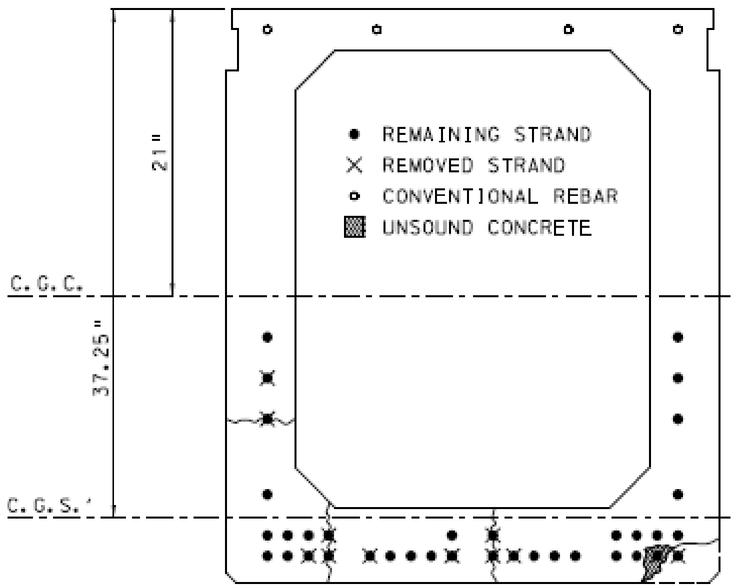

Figure 2 – Strand Configuration for Method A Analysis

Method A			
Row	# Strands	Dist from Bot of Beam (d_b)	# Strands x d_b
1	***10***	1.5"	15
2	***8***	3.0"	24
3	2	6.0"	12
4	***1***	12.0"	12
5	***1***	15.0"	15
6	2	18.0"	36
		C.G.S.' =	**4.75"**
		Strand Area =	**0.085 in^2**
		# Strands =	**24**

Table 2: Strand Layout and CGS' for analysis using Method A

Bridge Rating Evaluation Example using Method B:

Using Method B, a total of 4 equivalent strands are removed from the analysis. The exposed strand and the strand within the delaminated area are removed from the analysis. The strands above and immediately adjacent to the cracks within 3" are reduced to 75% of their area, and all other strands were reduced to 95% of their area. The final strand pattern used for analysis is shown in Figure 3.

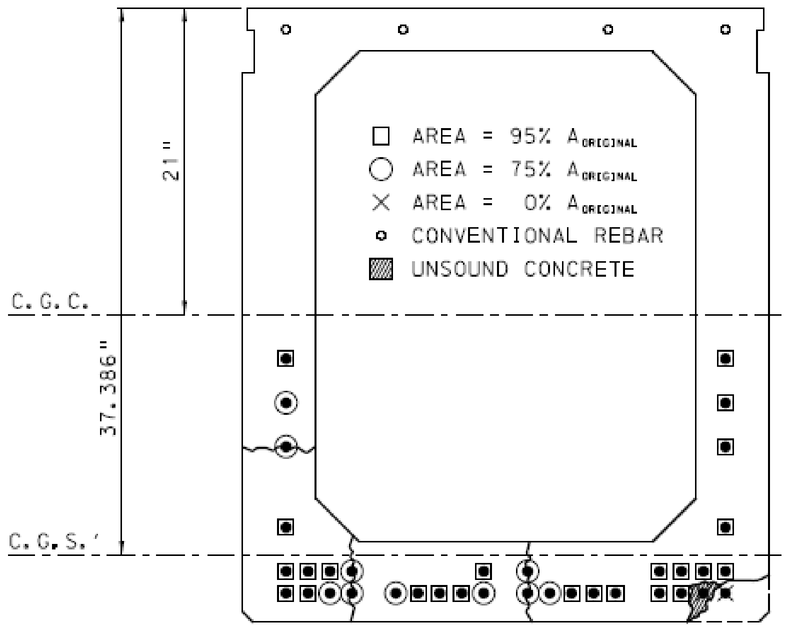

Figure 3 – Strand Configuration for Method B Analysis

Since the PS3 program does not accept a strand pattern with various individual strand areas, an equivalent C.G and area for the strands with section reduction needs to be determined for PS3 input. Table 3 shows the additional calculations required to provide this revised section.

Method B						
Row	Dist from Bot of Beam (d_b)	# Strands (0 % Area)	# Strands (75 % Area)	# Strands (95 % Area)	Remaining Area	Area x d_b
1	1.5"	2	6	10	1.190 in^2	1.79
2	3.0"	0	2	8	0.774 in^2	2.32
3	6.0"	0	0	2	0.162 in^2	0.97
4	12.0"	0	1	1	0.145 in^2	1.73
5	15.0"	0	1	1	0.145 in^2	2.17
6	18.0"	0	0	2	0.162 in^2	2.91
					C.G.S.' =	**4.614"**
					Strand Area =	**0.085 in^2**
					# Eqiv. Strands =	**30.3**

Table 3: Strand Layout and CGS' for Analysis using Method B

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APPENDIX IE 04-E

Corrugated Metal Culvert
Inspection Forms

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CORRUGATED METAL ARCH CULVERT INSPECTION FORMS

District: ____________ Inspected by: ____________

BMS #: ____________ Inspection Date: ____________

CULVERT GEOMETRY:

Height of Cover: ____________

Structure Length: ____________ Number of Barrels: ____________

Max Span Length: ____________ Max Barrel Length: ____________
(inlet to outlet)

Headwall Type: ____________ Wingwall Type: ____________

DEFECTS:

Is roadway settlement or repair apparent? Yes ☐ No ☐

Roadway Settlement/Repair Notes: ____________

Headwall and Wingwall Defects: ____________

Shape:

Is flattening or bulging present?	Yes ☐	No ☐
If yes, is it caused by corrosion?	Yes ☐	No ☐
Is this a change from the previous inspection?	Yes ☐	No ☐

If flattening/bulging is present complete the following:

Location of defect: ____________

Length of defect (along barrel): ____________ Width of defect (along arc): ____________

Additional Shape Notes: ____________

Maintenance Priority Codes for Corrosion Induced Flattening/Bulging:

> 3" distortion caused by corrosion =	Code 0 ☐
> 2", ≤ 3" distortion caused by corrosion =	Code 1 ☐
≤ 2" distortion caused by corrosion =	Code 2 ☐

CORRUGATED METAL ARCH CULVERT INSPECTION FORMS

District: ______________ Inspected by: ______________

BMS #: ______________________________ Inspection Date: ______________

DEFECTS (continued):

Corrosion and Section Loss: Original Metal Thickness: ____________

Notes: ____

____

____

____

____

____

____

Worst 4' Length of Corrosion:

Location: ________________________________

# of corrugations w/ holes: ________________________

% of corrugations w/ holes: ________________________

# of corrugations w/ 0, 25, 50 or 75% section loss*: _______ w/ 0% Estimated Section Loss

*Account for all remaining corrugations in the 4' length.
This data is used to calculate remaining life below.

_______ w/ 25% Estimated Section Loss

_______ w/ 50% Estimated Section Loss

_______ w/ 75% Estimated Section Loss

% bolts missing/ineffective: ________________________________

Consecutive bolts missing over 1' to 2' L? Yes ☐ No ☐

Maintenance Priority Codes for Corrosion (descriptions apply to worst 4' length documented above):

Severe corrosion (holes in ≥ 50% of corrugations) = Code 0 ☐
Serious corrosion (some minor holes) = Code 1 ☐
Advanced corrosion = Code 2 ☐

If Priority Code 2 is assigned above, estimate the remaining useful life of the culvert. To assist with this calculation there is a spreadsheet in the link on the BMS2 message board named: PennDOT Bridge Inspection Forms and Templates.

Maintenance Priority Codes for Bolt Deficiencies (descriptions apply to worst 4' length documented above):

Approximately 50% or more bolts/nuts missing or ineffective = Code 0 ☐
Consecutive bolts/nuts missing for a length of 1' to 2' = Code 1 ☐

CORRUGATED METAL ARCH CULVERT INSPECTION FORMS

District: ______________ Inspected by: ______________

BMS #: ______________________________ Inspection Date: ______________

Provide a sketch of the culvert and stream including alignment, scour conditions, debris/blockage, erosion, defects, corrosion/section loss and associated dimensions as applicable.

CORRUGATED METAL ARCH CULVERT INSPECTION FORMS

District: ______________ Inspected by: ______________

BMS #: ______________________________ Inspection Date: ______________

SUPPLEMENTAL INSPECTION NOTES/SKETCHES: