FHWA Computation Procedure for the Bridge Condition Measures

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16. Abstract The FHWA Computation Procedure for the Bridge Condition Measures presents the steps for Federal Highway Administration (FHWA) to compute bridge condition measures for the purpose of determining: (1) the minimum bridge condition level for each State (23 CFR 490.411); and (2) whether a State DOT has made significant progress towards the achievement of its bridge condition targets (23 CFR 490.109). While designed for internal use, FHWA is making the document public, to be transparent and give State DOTs a frame of reference when establishing their targets.			
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Table of Contents

1 Overview

This document presents the steps for Federal Highway Administration (FHWA) to compute bridge condition measures for the purpose of determining: (1) the minimum bridge condition level for each State (23 CFR 490.411); and (2) whether or not a State DOT has made significant progress towards the achievement of its bridge condition targets (23 CFR 490.109). The steps described in this document includes the measure computation procedure specified in 23 CFR 490.409. The structure query language (SQL) and pseudo-codes used in this document are only for illustrating computation logic and they are not intended for any specific database or computer application.

The definition of "bridges" is provided in 23 CFR 490.101 and 650.305.[1] Consistent with the defined definition in the CFR, the term "bridge" in this document encompasses both bridges and bridge-length culverts.

1.1 Performance Measures

Two bridge condition measures apply to the National Highway System (NHS) and were established under subpart D of 23 CFR part 490. The established bridge condition measures are:

(1) "Percentage of NHS bridges classified as in Good condition"; and

(2) "Percentage of NHS bridges classified as in Poor condition".

The main attributes of the bridge condition measures and targets are as follows:

- **The FHWA annually[2, 3] computes the "Percentage of NHS bridges classified as Structurally Deficient" as part of determining minimum condition level[4] for bridges carrying the National Highway System (NHS) starting in Calendar Year (CY) 2016 (see Section 1.3).**

- **The FHWA computes both bridge condition measures every two years[5] for the purpose of FHWA determination of whether a State DOT has made significant progress toward target achievement (see Section 1.4).**

- **Percentage of NHS bridges classified as Structurally Deficient and both bridge condition measures are expressed as percent deck area of bridges (see Section 2).**

- **Performance measures and targets cover all bridges carrying the NHS, which includes on- and off-ramps connected to the NHS within a State, and bridges carrying the NHS that cross a State border (23 CFR 490.403 and 23 CFR 490.411(a)).**

To ensure consistent definitions, a distinction between "performance measure" and "performance metric" was made in 23 CFR 490.101. A "metric" is defined as a quantifiable indicator of performance or

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[1] 23 CFR 650.305 - 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, 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. This definition is part of the National Bridge Inspection Standards that can be found at 23 CFR part 650, subpart C.

[2] 23 CFR 490.411(d)

[3] FHWA MAP-21 Q & A Webpage: https://www.fhwa.dot.gov/map21/qandas/qabridges.cfm

[4] 23 CFR 490.411(a) - Determine whether the Percentage of NHS bridges classified as Structurally Deficient is less than or equal to 10.0%.

[5] 23 CFR 490.109(b)

condition whereas a "measure" is defined as an expression based on a metric that is used to establish targets and to assess progress toward meeting the established targets. Therefore, "metrics" refer to the reported condition rating values for Deck (Item 58), Superstructure (Item 59), Substructure (Item 60) and Culverts (Item 62) in the National Bridge Inventory (NBI) whereas the "measures" refer to the percentages of deck area in Good or Poor condition, computed using the reported "metrics".

1.2   Data Sources

For the purpose of computing measures, determinations of whether a State DOT has maintained minimum bridge condition level and has made significant progress towards achievement of targets, the following data will be used.

- **National Bridge Inventory[6] (NBI)**: The governing data source for computing bridge condition measures and determining the percent of the total deck area of highway bridges classified as Structurally Deficient is NBI.

    o **Data Reporting:** The NBI is updated annually with State DOTs, Federal agencies, and tribal governments providing FHWA their NBI data submittals.[7] During processing of the submitted data, FHWA performs a variety of item checks, cross checks, null value checks, safety checks, etc. on the data. A detailed list of these checks may be found on the FHWA website.[8] Additionally, NBI data quality is reviewed to assess compliance with the National Bridge Inspection Standards (subpart C of 23 CFR part 650) in accordance with the National Bridge Inspection Program (NBIP) in 23 U.S.C. 144. The FHWA archives the NBI data twice during each calendar year (archived data in June is referred to as "mid-year" archived data and archived data in December is referred to as "end-year" archived data). All measure computations described in this document will be done using the "mid-year" archived data (archived NBI data in June). The term "mid-year archived data" in this document is synonymous with "data contained within the NBI as of June 15th" in 23 CFR 490.109(d)(3) and "the data cleared in the NBI as of June 15 of each year" in 23 CFR 490.411(d).

    o **Dataset Year**: The "year" in NBI dataset name refers to the year of data submittal to NBI. For example, the dataset submitted in March 2018 and FHWA archived in June 2018 is referred to as the "2018 NBI dataset", although the data within the dataset are from bridge inspections typically completed during previous calendar years.

    o **Data Items:** The bridge condition metrics - Deck, Superstructure, Substructure, and Culvert - come from NBI Data Items 58, 59, 60, and 62, respectively.[9] Also, the data items necessary to compute deck areas - Structure Length, Deck Width Out-to-Out, and Approach Roadway Width - come from NBI Data Items 49, 52, and 32, respectively.[10] For extracting NHS highway bridge data records, the data items State Code, Record Type, Type of Service on

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[6] National Bridge Inventory: http://www.fhwa.dot.gov/bridge/nbi.cfm; 23 CFR 490.409(b)

[7] State DOTs are required to submit their most current NBI data on highway bridges no later than March 15 of each year, to FHWA, as specified in 23 CFR 490.411(e). Federal agencies and tribes submit information to the NBI. See 23 CFR 650.315 and 650.303. Final Rule on "National Bridge Inspection Standards" RIN 2125–AE86 Federal Register - Vol. 69, No. 239, Pg. 74420 - December 14, 2004: https://www.gpo.gov/fdsys/pkg/FR-2004-12-14/pdf/04-27355.pdf

[8] NBI Data Check: https://www.fhwa.dot.gov/bridge/nbi/checks/

[9] 23 CFR 490.409(b) and 23 CFR 490.411(b)

[10] 23 CFR 490.409(c) and 23 CFR 411(c)

Bridge, NBIS bridge Length, and Highway System of Inventory Route come from NBI Data Items 1, 5A, 42A, 112, and 104, respectively.

For classifying whether a bridge is Structurally Deficient prior to CY 2018 (as referred to as "legacy definition"), additional data items - Waterway Adequacy and Structural Evaluation, NBI Data Items 71 and 67, respectively, were used. Per 23 CFR 490.411(b), these 2 data items are no longer used for Structural Deficiency classification as part of minimum bridge condition level determination. Please see Appendix C for more details on these data items used in legacy definition of Structurally Deficient bridges.

For the individual NBI Data Item names and numbers, the following naming convention is used in this document: "[ITEM_NAME_###]". For example, Deck (Item 58), Superstructure (Item 59) and Substructure (Item 60) are denoted as [DECK_058], [SUPERSTRUCTURE_059], and [SUBSTRUCTURE_060], respectively.

1.3   Annual Determination of Minimum Bridge Condition Level

This section provides a description of determining the minimum bridge condition level, as required in 23 U.S.C. 119(f)(2). Per this statutory requirement, FHWA must classify highway bridges as Structurally Deficient, and must compute the percent of the total deck area of highway bridges carrying the NHS (including on- and off-ramps connecting to the NHS) that are classified as Structurally Deficient. The FHWA must make these determinations each year. Accordingly, each year, FHWA will use the mid-year archived data[11] of the determination year to assess whether the percent of the total deck area of bridges in a State on the NHS classified as Structurally Deficient is greater than 10.0 percent. In addition to assessing the mid-year archived data, FHWA will look at the assessment results made in the two preceding years on the respective mid-year archived data.

If FHWA determines that the percent of the total deck area of bridges in a State on the NHS classified as Structurally Deficient is greater than 10.0 percent for 3 consecutive years (the year of determination and the two preceding years), the penalty specified in 23 U.S.C. 119(f)(2) and 23 CFR 490.413 will be imposed on that State DOT during the fiscal year beginning October 1 of the year the annual determination is made. As specified in 23 CFR 490.413, if FHWA determines a State DOT is subject to the penalty, then that State DOT must obligate and set aside from the National Highway Performance Program (NHPP) an amount equal to 50 percent of the State's Highway Bridge Program (HBP) apportionment in Federal Fiscal Year (FY) 2009.[12] The set aside funds are to be used only for eligible projects on bridges on the NHS.

As described in 23 CFR 490.411(b), the FHWA definition and classification of Structurally Deficient changed beginning in CY 2018. The following determination methods for the Minimum Bridge Condition Level are applied:

- **Minimum Bridge Condition Level Determinations in CY 2016 and CY 2017** - the FHWA definition and classification of Structural Deficient carries forward from the now obsolete Highway Bridge

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[11] 23 CFR 490.411(d) - The FHWA will annually determine the percentage of the deck area of NHS bridges classified as Structurally Deficient for each State DOT and identify State DOTs that do not meet the minimum level of condition for NHS bridges based on data cleared in the NBI as of June 15 of each year.
[12] Apportionment of funds for the Highway Bridge Program Authorized for FY2009: https://www.fhwa.dot.gov/legsregs/directives/notices/n4510687.cfm

Program (described in Appendix C). In this document, this method/classification is labeled as the "legacy method/classification".

- **Minimum Bridge Condition Level Determinations in CY 2018 and every year thereafter** – the definition of a Structurally Deficient bridge has the same definition as a bridge classified as in Poor condition (described in Section 2). In this document, this method/classification is labeled as the "new method/classification".

For example, for the determination in 2018, FHWA will use the 2018 NBI dataset[13] to assess whether percent of the total deck area of bridges in a State on the NHS classified as Structurally Deficient is greater than 10.0 percent by using the "new method/classification" (classified as Poor condition, as provided in Section 2.2). As part of the determination in 2018, FHWA will obtain the result of assessment made with "legacy method/classification" in 2017 on the 2017 NBI dataset[14] and the result of assessment made with "legacy method/classification" in 2016 on the 2016 NBI dataset.[15] If FHWA determines that the percent of the total deck area of bridges in a State on the NHS classified as Structurally Deficient is greater than 10.0 percent in each of the assessments in 2016, 2017, and 2018, then the penalty specified in 23 CFR 490.413 will be imposed on that State DOT during the fiscal year beginning October 1, 2018.

1.4 Biennial Determination of Significant Progress towards Achieving NHS Bridge Targets

Starting in 2020[16] and biennially thereafter, FHWA performs data extraction of the mid-year archived data from NBI for computing both bridge condition measures for significant progress determination. 23 CFR 490.109(e)(2) stipulates that a State DOT is determined to have made significant progress toward meeting its targets for a measure when either:

- The actual condition level is better than the baseline condition/performance; or

- The actual condition level is equal to or better than the established target.

The baseline condition are snapshot condition levels at the beginning of a Performance Period and are represented by the measures computed with the NBI data archived in June of the year in which State Baseline Performance Period Reports are due (in Calendar Years 2018, 2022, 2026, etc.).[17] The snapshot condition levels at the midpoint of a Performance Period are referred to as the "2-year condition", and the snapshot condition at the end of a Performance Period are referred as the "4-year condition". The 2-year condition is the condition calculated with the NBI data archived in June of the year in which State

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[13] 2018 Mid-Year Archived Dataset

[14] 2017 Mid-Year Archived Dataset

[15] 2016 Mid-Year Archived Dataset

[16] 23 CFR 490.109(c) - The FHWA will determine significant progress toward the achievement of a State DOT's NHPP targets after the State DOT submits the Mid Performance Period Progress Report for progress toward the achievement of 2-year targets, and again after the State DOT submits the Full Performance Period Progress Report for progress toward the achievement of 4-year targets. Accordingly, the first significant progress determination will be made in 2020 (after the State DOT submits the Mid Performance Period Progress Report for the first performance period).

[17] 23 CFR 490.109(d)(1)(vi) - Baseline condition/performance data contained in NBI of the year in which the Baseline Period Performance Report is due to FHWA that represents baseline conditions/performances for the performance period.

Mid Performance Period Progress Reports are due (in Calendar Years 2020, 2024, 2028, etc.).[18] The 4-year condition is the condition calculated with the NBI data archived in June of the year in which State Full Performance Period Progress Reports are due (in Calendar Years 2022, 2026, 2030, etc.).[19]

Accordingly, for the determination in CY 2020, FHWA will use the mid-year archived NBI dataset in 2020 for computing the actual 2-year condition level (for the 1st Performance Period) and will use mid-year archived NBI dataset in 2018 for computing baseline condition/performance. Similarly, for the determination in CY 2022, FHWA will use the mid-year archived NBI dataset in 2022 for computing the actual 4-year condition level (for the 1st Performance Period) and will use mid-year archived NBI dataset in in 2018 for computing baseline condition/performance.

2 Measure Computation Methodology

This section describes details for computing bridge condition measures. As Section 1.1 discussed, the two bridge condition measures are:

> **(1) "Percentage of NHS bridges classified as in Good condition"; and**

> **(2) "Percentage of NHS bridges classified as in Poor condition".**

Accordingly, the bridge condition measure computation is performed in the following general form, as described in 23 CFR 490.409(c).

$$\%\_Good = \frac{Deck\_Area\_Good}{Deck\_Area\_Good + Deck\_Area\_Fair + Deck\_Area\_Poor} \times 100$$

$$\%\_Poor = \frac{Deck\_Area\_Poor}{Deck\_Area\_Good + Deck\_Area\_Fair + Deck\_Area\_Poor} \times 100$$

Where,

%_Good:	"Percentage of NHS bridges classified as in Good condition" measure;
%_Poor:	"Percentage of NHS bridges classified as in Poor condition" measure;
Deck_Area_Good:	total deck area of NHS bridges classified as in Good condition;
Deck_Area_Fair:	total deck area of NHS bridges classified as in Fair condition; and
Deck_Area_Poor:	total deck area of NHS bridges classified as in Poor condition

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[18] 23 CFR 490.109(c) and 23 CFR 490.109(d)(1)(iii) - The most recently available data contained within the NBI as of June 15th of the year in which the significant progress determination is made for targets established for NHS bridge condition measures.
[19] Ibid.

As indicated in Section 1, the term "bridge" in Section 2 encompasses both bridges and bridge-length culverts. Deck area of a "bridge" is a product of the length and the width of that bridge. Please see more detailed measure equations in Section 2.3.

2.1 Data Preparation

This section describes the steps required to prepare data for measure computation. The NBI data records for bridges carrying NHS should have **all** of the following characteristics:

Table 1 – Criteria for highway carrying the NHS including on- and off-ramps connecting to the NHS

Description	Criteria
The correct coding for the desired state. A list of state codes is included on Page 1 of the *Coding Guide*[20].	**(**[STATE_CODE_001] = "XXX"**) AND**
Only overpassing records.	**(**[RECORD_TYPE_005A] = '1'**) AND**
A bridge carries vehicular traffic.	**(**[TYPE_OF_SERVICE_042A] IN ('1', '4', '5', '6', '7', '8')**) AND**
Whether or not a bridge meets (or exceeds) the minimum length requirement for the purpose of NBIS eligibility as defined in the *Coding Guide*.	**(**[NBIS_BRIDGE_LENGTH_112] = 'Y'**) AND**
A bridge is greater than 6.1 meters in length.	**(**[STRUCTURE_LENGTH_049] >= 000061**) AND**
A bridge carrying the NHS, including on- and off-ramps connecting to the NHS.	**(**[HIGHWAY_SYSTEM_OF_THE_INVENTORY_ROUTE_104] = '1'**)**

[TYPE_OF_SERVICE_042A] IN ('1', '4', '5', '6', '7', '8') means a value of [TYPE_OF_SERVICE_042A] is equal to '1', '4', '5', '6', '7', or '8'.

The remainder of Section 2 only applies to the data records that satisfy the criteria in Table 1 above.

2.2 Classification

For computing measures, all bridges carrying NHS must be classified into the following categories[21]:

(1) "Good condition"

(2) "Fair condition"

(3) "Poor condition"

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[20] Recording and Coding Guide for the Structure Inventory and Appraisal of the Nations Bridges: https://www.fhwa.dot.gov/bridge/nbi.cfm

[21] 23 CFR 490.407(a)

23 CFR 490.409(b) stipulates that the assignment of a classification of Good, Fair, or Poor must be based on the bridge's lowest condition ratings for [DECK_058], [SUPERSTRUCTURE_059], [SUBSTRUCTURE_060], and [CULVERT_062] as follow:

- **Good**: When the lowest rating of the 4 NBI Items is 7, 8, or 9;

- **Fair**: When the lowest rating of the 4 NBI Items is 5 or 6; or

- **Poor**: When the lowest rating of the 4 NBI Items is 0, 1, 2, 3, or 4.

The classification criteria in Table 2 below is based on 23 CFR 490.409(b).

Table 2 – Good, Fair, and Poor Classification Criteria

Criteria	Classification	Description
IF **MIN(**[DECK_058],[SUPERSTRUCTURE_059], [SUBSTRUCTURE_060],[CULVERT_062]**)** IN (7,8,9)	**THEN** Good	If a bridge's lowest value of Items 58, 59, 60, and 62 is coded as 7, 8, or 9, then the bridge is classified as in Good condition.
IF **MIN(**[DECK_058],[SUPERSTRUCTURE_059], [SUBSTRUCTURE_060],[CULVERT_062]**)** IN (5,6)	**THEN** Fair	If a bridge's lowest value of Items 58, 59, 60, and 62 is coded as 5 or 6, then the bridge is classified as in Fair condition.
IF **MIN(**[DECK_058],[SUPERSTRUCTURE_059], [SUBSTRUCTURE_060],[CULVERT_062]**)** IN (0,1,2,3,4)	**THEN** Poor	If a bridge's lowest value of Items 58, 59, 60, and 62 is coded as 0, 1, 2, 3 or 4, then the bridge is classified as in Poor condition.

- **MIN([DECK_058],[SUPERSTRUCTURE_059],[SUBSTRUCTURE_060],[CULVERT_062])** means the lowest value of [DECK_058],[SUPERSTRUCTURE_059], [SUBSTRUCTURE_060], and [CULVERT_062]; and

- **IN (5,6)** means a value is equal to 5 or 6.

The logic in Table 2 will classify a bridge as in Good, Fair, or Poor condition even when its data record has one or more unreported [DECK_058], [SUPERSTRUCTURE_059], [SUBSTRUCTURE_060] and [CULVERT_062] value(s). In this case, the classification will only be done with one or more reported [DECK_058], [SUPERSTRUCTURE_059], [SUBSTRUCTURE_060], and [CULVERT_062] value(s). If the data record for a bridge has all four missing [DECK_058], [SUPERSTRUCTURE_059], [SUBSTRUCTURE_060] and [CULVERT_062] values[22] (e.g., due to the time lag between data reporting for of newly constructed bridge and the inspection), the data record for that bridge will not be classified and will be excluded from the measure computation.

23 CFR 490.409(c) stipulates that the width dimension for deck area of a bridge-length culvert would come from [APPROACH_ROAD_WIDTH_032] for bridges where the roadway is on a fill (i.e., traffic does not directly run on the top slab or wearing surface of the bridge) and the headwalls do not affect the flow of traffic. If Item 52 ([DECK_WIDTH_052]) is unreported or coded zero, then the deck width comes

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[22] It is possible that a data record has all four missing [DECK_058], [SUPERSTRUCTURE_059], [SUBSTRUCTURE_060] and [CULVERT_062] values, but FHWA expects this occurrence to be highly unusual.

from the reported value in Item 32 ([APPROACH_ROAD_WIDTH_032]). Otherwise, deck width dimension of a bridge comes from value in Item 52 (i.e., [DECK_WIDTH_052]) as shown in Table 3 below. If the data record for a bridge has missing or zero values for both [DECK_WIDTH_052] and [APPROACH_ROAD_WIDTH_032][23] (e.g., due to the time lag between data reporting for of newly constructed bridge and the inspection), then the data record for that bridge will be excluded from the measure computation.

Table 3– Deck Area Computation Method

Criteria	Deck_Area	Description
`IF` `(`[DECK_WIDTH_052] IS NULL OR [DECK_WIDTH_052] = 0`)`	`THEN` [STRUCTURE_LENGTH_049] X [APPROACH_ROAD_WIDTH_032]	If Item 52 is unreported or coded zero, then the deck width comes from the reported value in Item 32.
`Else`	`THEN` [STRUCTURE_LENGTH_049] X [DECK_WIDTH_052]	Otherwise, deck width dimension comes from value in Item 52.

As described above, if a bridge data record satisfies any one of the condition in Table 4, then that bridge data record will be excluded (or discarded) from the measure computation.

Table 4 – Criteria for Data Records Exclusion from the Measure Computation

Condition Description	Condition Expression	Measure Computation
If a bridge has Items 58, 59, 60 and 62 values unreported.	`IF (`([DECK_058] IS NULL) AND ([SUPERSTRUCTURE_059] IS NULL) AND ([SUBSTRUCTURE_060] IS NULL) AND ([CULVERT_062] IS NULL)`)`	`Then` bridge data record will be excluded (or discarded) from the measure computation
If a bridge's Items 32 and 52 values are unreported or equal to zero.	`IF (`([DECK_WIDTH_052] IS NULL) OR ([DECK_WIDTH_052] = 0)`) AND` `(`([APPROACH_ROAD_WIDTH_032] IS NULL) OR ([APPROACH_ROAD_WIDTH_032] = 0)`)`	`Then` bridge data record will be excluded (or discarded) from the measure computation

- `NULL` means unreported.

2.3   General Bridge Condition Measure Equations

The measure equations in the beginning of Section 2 are re-written with the explanation provided in Section 2.2 and as described in 23 CFR 490.409(c).

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[23] It is possible that a data record has missing or zero values for both [DECK_WIDTH_052] and [APPROACH_ROAD_WIDTH_032], but FHWA expects this occurrence to be highly unusual.

$$\%\_Good = \frac{Deck\_Area\_Good}{Deck\_Area\_Good + Deck\_Area\_Fair + Deck\_Area\_Poor} \times 100$$

$$\%\_Poor = \frac{Deck\_Area\_Poor}{Deck\_Area\_Good + Deck\_Area\_Fair + Deck\_Area\_Poor} \times 100$$

Where,

%_Good: "Percentage of NHS bridges classified as in Good condition" Measure (rounded to the nearest one one-tenth of a percent);

%_Poor: "Percentage of NHS bridges classified as in Poor condition" Measure (rounded to the nearest one one-tenth of a percent);

Deck_Area_Good: total deck area of NHS bridges classified as in Good condition;

$$Deck\_Area\_Good = \sum_{g=1}^{GOOD} ([Deck\_Area])_{Bridge\ g}$$

GOOD: total number of the applicable bridges, where their condition is Good, as defined in Section 2.2;

Bridge g: a bridge determined to be in Good condition per Table 2 in Section 2.2; and

[Deck_Area]: deck area of a bridge computed per Table 3 in Section 2.2 (excluding the records described in Table 4 in Section 2.2).

Deck_Area_Fair: total deck area of NHS bridges classified as in Fair condition;

$$Deck\_Area\_Fair = \sum_{f=1}^{FAIR} ([Deck\_Area])_{Bridge\ f}$$

FAIR: total number of the applicable bridges, where their condition is Fair, as defined in Section 2.2;

Bridge f: a bridge determined to be in Fair condition per Table 2 in Section 2.2; and

[Deck_Area]: deck area of a bridge computed per Table 3 in Section 2.2 (excluding the records described in Table 4 in Section 2.2).

Deck_Area_Poor:total deck area of NHS bridges classified as in Poor condition;

$$Deck\_Area\_Poor = \sum_{p=1}^{POOR} ([Deck\_Area])_{Bridge\ p}$$

POOR: total number of the applicable bridges, where their condition is Poor, as defined in Section 2.2;

Bridge p: a bridge determined to be in Poor condition per Table 2 in Section 2.2; and

[Deck_Area]: deck area of a bridge computed per Table 3 in Section 2.2 (excluding the records described in Table 4 in Section 2.2).

Appendix A – References

- Final Rule on "National Performance Management Measures; Assessing Pavement Condition for the National Highway Performance Program and Bridge Condition for the National Highway Performance Program": Docket No. FHWA–2013–0053, RIN 2125–AF53, Federal Register - Vol. 82, No. 11 - January 18, 2017: https://www.gpo.gov/fdsys/pkg/FR-2017-01-18/pdf/2017-00550.pdf

- National Bridge Inventory: https://www.fhwa.dot.gov/bridge/nbi.cfm

Appendix B – Acronyms Table

Acronym	Full Form
CFR	Code of Federal Regulation
CY	Calendar Year
FHWA	Federal Highway Administration
FY	Federal Fiscal Year
NBI	National Bridge Inventory
NBIS	National Bridge Inspection Standards
State DOT	State Department of Transportation
U.S.C.	United States Code

Appendix C – Determinations of the Percent of the Total Deck Area of Bridges in a State on the NHS Classified as Structurally Deficient (the legacy definition/method from the obsolete Highway Bridge Program)

Appendix C describes the obsolete Highway Bridge Program classification of highway bridges as Structurally Deficient, and how to compute the percent of the total deck area of highway bridges classified as Structurally Deficient carrying the NHS, including on- and off-ramps connecting to the NHS.

Consistent with Sections 1 and 2, in Appendix C, the term "bridge" encompasses both bridges and bridge-length culverts.

C1. Data Preparation for Legacy Method

The data extraction step for this section is the same as the data extraction method for measure computation, described in Section 2.1.

C2. Classification of Structural Deficiency (Legacy Definition):

This section describes FHWA definition and classification of structural deficiency carries forward from the now obsolete Highway Bridge Program. Under the legacy definition/method, a bridge is classified as Structurally Deficient if it meets **any one** of the following criteria (please note the term "bridge" in Table A below encompasses both bridge and bridge-length culvert):

Table A – Criteria for Determining Structural Deficiency (Legacy Definition)[24]

Criteria	Description
([DECK_058] IN (0,1,2,3,4)) OR ([SUPERSTRUCTURE_059] IN (0,1,2,3,4)) OR ([SUBSTRUCTURE_060] IN (0,1,2,3,4))	A bridge with Item 58, Item 59 or Item 60 coded as 0, 1, 2, 3, or 4 is classified as Structurally Deficient.
([CULVERT_062] IN (0,1,2,3,4)) AND ([STRUCTURE_TYPE_043B] = 19)	"[STRUCTURE_TYPE_043B] = 19" means that the bridge is a culvert. A culvert with Item 62 coded as 0, 1, 2, 3, or 4 is classified as Structurally Deficient.
([SERVICE_UND_042B] IN (0, 5,6,7,8,9)) AND ([WATERWAY_ADEQUACY_071] IN (0,1,2))	"[SERVICE_UND_042B] IN (0,5,6,7,8,9)" means [SERVICE_UND_042B] = 0[25], 5, 6, 7, 8, or 9; and these values indicates that the bridge crosses over a waterway. A bridge that crosses over a waterway with Item 71 coded as 0, 1, or 2 is classified as Structurally Deficient.

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[24] The NBI items used for determining whether a bridge was classified as Structurally Deficient, prior to calendar year 2018, are identified in 23 CFR 490.411(b). In addition, FHWA has guidance that describes in more detail the methodology for classifying a bridge as Structurally Deficient, prior to calendar year 2018. This guidance on the methodology is included in the "Additional Guidance" on 23 CFR part 650 subpart D (dated September 30, 1992): https://www.fhwa.dot.gov/bridge/0650dsup.cfm. The classification and computation procedures provided in Appendix C are consistent with the methodology described in the "Additional Guidance" on 23 CFR part 650 subpart D.

[25] [SERVICE_UND_042B] = 0 indicates "Other" type of service under the bridge so the bridge might cross over a waterway

Criteria	Description
([STRUCTURAL_EVAL_067] IN (0,1,2)**)**	A bridge with Item 67 coded as 0, 1, or 2 is classified as Structurally Deficient. Note Item 67 is an NBI generated code. Please see below for more details on how Item 67 is calculated.

Please note that the "10-Year Rule"[26] is no longer applicable in determining if a highway bridge is to be classified as Structurally Deficient because the "10-Year Rule" only applied to the now obsolete Highway Bridge Program. It does not apply to any programs under the MAP-21 or the FAST Act. Please see the MAP-21 Bridges Questions & Answers webpage[27] for more information.

C2a. Item 67: Structural Evaluation

As documented in the *Coding Guide,* [STRUCTURAL_EVAL_067] is calculated and coded by the NBI. [STRUCTURAL_EVAL_067] coding is a 2-step process.

First, a 0 to 9 rating code is determined for each bridge based on Table 1 (on Page 47) of the *Coding Guide*. This table uses a number of reported values from the NBI dataset as follows: [ADT_029], [INVENTORY_RATING_066], [OPEN_CLOSED_POSTED_041], [FUNCTIONAL_CLASS_026], and [WORK_PROPOSED_075A]. Table B provided below further explains Table 1 in the *Coding Guide* by capturing the ranges of [INVENTORY_RATING_066] values and providing clarity for the bridges carrying Interstate, Freeway or Expressway. Bridges with [FUNCTIONAL_CLASSIFICATION_026] coded as 1, 11, or 12, indicating the road is an Interstate or Other Freeway or Expressway, default to using the >5000 ADT column regardless of the coded [ADT_029].

The logic that is used to differentiate between the [STRUCTURAL_EVAL_067] codes of 3, 2, and 0 is as follows:

- If the code for [INVENTORY_RATING_066] is less than the lower limit specified for a [STRUCTURAL_EVAL_067] coding of 4, and [OPEN_CLOSED_POSTED_041] is coded as "K" indicating the bridge is closed, then [STRUCTURAL_EVAL_067] is coded as 0.

- If the code for [INVENTORY_RATING_066] is less than the lower limits specified for a [STRUCTURAL_EVAL_067] coding of 4, and [WORK_PROPOSED_075A] is coded 31 or 32, which indicates the bridge is recommended for replacement, then [STRUCTURAL_EVAL_067] is coded as 2.

- If the code for [INVENTORY_RATING_066] is less than the lower limit specified for a [STRUCTURAL_EVAL_067] coding of 4 and does not meet either criteria in the above bullets, then it is coded as 3.

The difference between a code of 3 and a code of 2 for [STRUCTURAL_EVAL_067] is described in the language of Table 1 of the Coding Guide, as a code of 3 states, "requires corrective action," while a code of 2 states, "requires replacement."

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[26] FHWA's "10-Year Rule": http://www.fhwa.dot.gov/bridge/0650dsup.cfm
[27] Question 7 in Bridges Questions & Answers (Posted 9/25/2012, Updated 10/9/2013): http://www.fhwa.dot.gov/map21/qandas/qabridges.cfm

Please note Table B below applies to all bridges (including bridge-length culverts).

Table B – Step 1: Obtaining [Table_B_Code] Values (Legacy Definition)

[Table_B_Code]	[ADT_029] >= 0 AND [ADT_029] <= 500 AND [FUNCTIONAL_CLASS_026] IN (2,6,7,8,9,14,16,17,19)	[ADT_029] >= 501 AND [ADT_029] <= 5000 AND [FUNCTIONAL_CLASS_026] IN (2,6,7,8,9,14,16,17,19)	([ADT_029] >5000 AND [FUNCTIONAL_CLASS_026] IN (2,6,7,8,9,14,16,17,19)) OR ([FUNCTIONAL_CLASS_026] IN (1,11,12))
9	[INVENTORY_RATING_066] > **32.4**	[INVENTORY_RATING_066] > **32.4**	[INVENTORY_RATING_066] > **32.4**
8	[INVENTORY_RATING_066] = **32.4**	[INVENTORY_RATING_066] = **32.4**	[INVENTORY_RATING_066] = **32.4**
7	[INVENTORY_RATING_066] < **32.4** AND [INVENTORY_RATING_066] ≥ **27.9**	[INVENTORY_RATING_066] < **32.4** AND [INVENTORY_RATING_066] ≥ **27.9**	[INVENTORY_RATING_066] < **32.4** AND [INVENTORY_RATING_066] ≥ **27.9**
6	[INVENTORY_RATING_066] < **27.9** AND [INVENTORY_RATING_066] ≥ **20.7**	[INVENTORY_RATING_066] < **27.9** AND [INVENTORY_RATING_066] ≥ **22.5**	[INVENTORY_RATING_066] < **27.9** AND [INVENTORY_RATING_066] ≥ **24.3**
5	[INVENTORY_RATING_066] < **20.7** AND [INVENTORY_RATING_066] ≥ **16.2**	[INVENTORY_RATING_066] < **22.5** AND [INVENTORY_RATING_066] ≥ **18.0**	[INVENTORY_RATING_066] < **24.3** AND [INVENTORY_RATING_066] ≥ **19.8**
4	[INVENTORY_RATING_066] < **16.2** AND [INVENTORY_RATING_066] ≥ **10.8**	[INVENTORY_RATING_066] < **18.0** AND [INVENTORY_RATING_066] ≥ **12.6**	[INVENTORY_RATING_066] < **19.8** AND [INVENTORY_RATING_066] ≥ **16.2**
3	[INVENTORY_RATING_066] < **10.8** AND ([OPEN_CLOSED_POSTED_041] ≠ "K" OR [OPEN_CLOSED_POSTED_041] IS NULL) AND ([WORK_PROPOSED_075A] IS NULL OR IN (33,34,35,36,37,38))	[INVENTORY_RATING_066] < **12.6** AND ([OPEN_CLOSED_POSTED_041] ≠ "K" OR [OPEN_CLOSED_POSTED_041] IS NULL) AND ([WORK_PROPOSED_075A] IS NULL OR IN (33,34,35,36,37,38))	[INVENTORY_RATING_066] < **16.2** AND ([OPEN_CLOSED_POSTED_041] ≠ "K" OR [OPEN_CLOSED_POSTED_041] IS NULL) AND ([WORK_PROPOSED_075A] IS NULL OR IN (33,34,35,36,37,38))
2	[INVENTORY_RATING_066] < **10.8** AND ([OPEN_CLOSED_POSTED_041] ≠ "K" OR [OPEN_CLOSED_POSTED_041] IS NULL) AND [WORK_PROPOSED_075A] IN (31,32)	[INVENTORY_RATING_066] < **12.6** AND ([OPEN_CLOSED_POSTED_041] ≠ "K" OR [OPEN_CLOSED_POSTED_041] IS NULL) AND [WORK_PROPOSED_075A] IN (31,32)	[INVENTORY_RATING_066] < **16.2** AND ([OPEN_CLOSED_POSTED_041] ≠ "K" OR [OPEN_CLOSED_POSTED_041] IS NULL) AND [WORK_PROPOSED_075A] IN (31,32)
0	[INVENTORY_RATING_066] < **10.8** AND [OPEN_CLOSED_POSTED_041] = "K"	[INVENTORY_RATING_066] < **12.6** AND [OPEN_CLOSED_POSTED_041] = "K"	[INVENTORY_RATING_066] < **16.2** AND [OPEN_CLOSED_POSTED_041] = "K"

Note: NULL indicates value unreported.; [FUNCTIONAL_CLASS_026] IN (2,6,7,8,9,14,16,17,19) refers to all functional classes except Interstates, Freeways and Expressways; and [FUNCTIONAL_CLASS_026] IN (1,11,12) refers to Interstate or Freeway/Expressway functional classifications.

The second step is to obtain a final [STRUCTURAL_EVAL_067] value for each bridge using the values from Table B above ([Table_B_Code]) and other data items such as [INVENTORY_RATING_066], [STRUCTURE_TYPE_043B], [SUPERSTRUCTURE_COND_059], [SUBSTRUCTURE_COND_060], [CULVERT_COND_062], [ADT_029], and [FUNCTIONAL_CLASS_026]. The process for obtaining a final value for [STRUCTURAL_EVAL_067] is illustrated in Table C below. Note the term "bridge" in Table C below encompasses both bridge and bridge-length culvert, as described in Section 1. Please also note that the process in Table C occurs in a specific order.

Table C – Step 2: [STRUCTURAL_EVAL_067] Value Assignment (Legacy Definition)

Order of Operation*	Condition	[STRUCTURAL_EVAL_067]	Description
i	[INVENTORY_RATING_066] IS NULL	"*"	If Item 66 is missing, then "*". In this case, deficiency status is based on the criteria in Table A.
ii	([STRUCTURE_TYPE_043B] ≠ 19 OR [STRUCTURE_TYPE_043B] IS NULL) AND ([SUPERSTRUCTURE_COND_059] = 1 OR [SUBSTRUCTURE_COND_060] = 1)	0	If a bridge is not a culvert, and if the value of either Item 59 or Item 60 is 1, then Item 67 = zero.
iii	[STRUCTURE_TYPE_043B] = 19 AND [CULVERT_COND_062] = 1	0	For a culvert, if Item 62 is 1, then then Item 67 = zero.
iv	[STRUCTURE_TYPE_043B] ≠ 19 OR [STRUCTURE_TYPE_043B] IS NULL	MIN([Table_B_Code], [SUPERSTRUCTURE_COND_059], [SUBSTRUCTURE_COND_060])	If a bridge is not a culvert, Item 67 is equal to the smallest value of Item 59, Item 60, or the [Table_B_Code] value from Table B above. Note, bridges carrying Interstate, Freeway or Expressway ([FUNCTIONAL_CLASS_026] IN (1, 11, 12)) will still obtain [Table_B_Code] even when [ADT_029] is NULL for that bridge.
v	[STRUCTURE_TYPE_043B] = 19	MIN([Table_B_Code], [CULVERT_COND_062])	For a culvert, Item 67 is equal to the smallest value of Item 62 or the value from Table B above. Note, culverts carrying Interstate, Freeway or Expressway ([FUNCTIONAL_CLASS_026] IN (1, 11, 12)) will still obtain [Table_B_Code] even when [ADT_029] is null for that culvert.
vi	([ADT_029] IS NULL OR [FUNCTIONAL_CLASS_026] IS NULL) AND [STRUCTURE_TYPE_043B] ≠ 19	MIN([SUPERSTRUCTURE_COND_059], [SUBSTRUCTURE_COND_060])	For a bridge that is not a culvert, if Item 29 or Item 26 is null, then Item 67 is equal to the smallest value of Item 59 or Item 60.
vii	([ADT_029] IS NULL OR [FUNCTIONAL_CLASS_026] IS NULL) AND [STRUCTURE_TYPE_043B] = 19	[CULVERT_COND_062]	For a culvert, if Item 29 or Item 26 is null, then assign Item 62 value to Item 67.

Note: * Operation sequence for assigning [STRUCTURAL_EVAL_067] value; MIN(.....) means the smallest numeric value of the values in the parenthesis; and NULL indicates value unreported.

As indicated in Table C above, if the field for [INVENTORY_RATING_066], is null, [STRUCTURAL_EVAL_067] will be coded as "*," but this does not cause the bridge to be classified as Structurally Deficient. A bridge with [STRUCTURAL _EVAL_067] coded as "*" is classified as Structurally Deficient only if [DECK_58], [SUPERSTRUCTURE_59], [SUBSTRUCTURE_60], or [CULVERT_062] are coded as 0, 1, 2, 3, or 4, or if [WATERWAY_ADEQUACY_071] is coded as 0, 1, or 2. Please see Table A above for more details.

C2b. Item 58—Deck Condition, Item 59—Superstructure Condition, Item 60—Substructure Condition and Item 62—Culvert Condition:

These component condition rating items are coded by the inspector in accordance with pages 37 -39, and 41-42 of the Coding Guide. These items describe the general condition of the entire component on a scale from 0, representing a totally failed condition, to 9, representing an excellent condition. These items trigger a Structurally Deficient classification for a bridge when any one of them is coded as 0, 1, 2, 3, or 4.

C2c. Item 71—Waterway Adequacy

[WATERWAY_ADEQUACY_071] is coded by the state in accordance with pages 45 and 56-57 of the Coding Guide. This item describes the adequacy of the bridge's hydraulic opening. The Coding Guide contains a table that provides the appropriate coding based on the Functional Classification of the route and whether flood waters will overtop the bridge based on various return-period floods: greater than 100 years, 11 to 100 years, 3 to 10 years, and less than 3 years. This item triggers a Structurally Deficient classification for a bridge when it is coded as 0, 1, or 2.

C3. Calculation of Deck Area (Legacy Method):

Deck Area is calculated as [DECK_WIDTH_052] x [STRUCTURE_LENGTH_049] for all bridges (i.e., all bridges and all bridge-length culverts).

For culverts and bridges under fill, or bridges without structural decks, Item 52 is typically coded as 0. These bridges are therefore not included in the calculation of Deck Area or, if Structurally Deficient, the calculation of Structurally Deficient Deck Area. However, culverts with Item 52 coded greater than 0 are included in the calculation of Deck Area and, if Structurally Deficient, the calculation of Structurally Deficient Deck Area.

C4 Calculation of the Percent of the Total Deck Area of Highway Bridges Classified as Structurally Deficient Carrying the NHS (Legacy Method):

For an NBI submittal year, the Percent of the total deck area of highway bridges classified as Structurally Deficient carrying the NHS (**Percent SD $_{YR}$**) is computed by the sum of the deck areas of all Structurally Deficient highway bridges carrying NHS within a State divided by the sum of the deck areas of all highway bridges carrying NHS within a State. A generalized equation (23 CFR 490.411(c)) is shown below. Please note that the computed percentage is rounded to the nearest one one-tenth of a percent, and the term "bridge" in equation below encompasses both bridge and bridge-length culvert, as described in Section 1.

Percent SD $_{YR}$ =

$$100 \times \frac{\sum_{SD=1}^{STRUCTURALLY\ DEFICIENT} [DECK\_AREA]_{Bridge\ SD}}{\sum_{s=1}^{TOTAL} [DECK\_AREA]_{Bridge\ s}}$$

Where,

Percent SD $_{YR}$:   Calculated percentage of total deck area of highway bridges classified as Structurally Deficient carrying the NHS for an NBI submittal year.
⟨rounded to the nearest one one-tenth of a percent⟩

s: A bridge carrying the NHS, as described in C1 (or Table 1 in Section 2.1.

SD: A bridge carrying the NHS and classified as Structurally Deficient, as described in Table A in C2.

[DECK_AREA]$_{Bridge\ s}$:   The calculated deck area of a bridge carrying the NHS, as described in C3.

[DECK_AREA]$_{Bridge\ SD}$:   The calculated deck area of a bridge carrying the NHS and classified as Structurally Deficient, as described in C3.

STRUCTURALLY DEFICIENT: The total number of bridges carrying the NHS that are classified as Structurally Deficient within a State.

TOTAL: The total number of bridges carrying the NHS within a state.