Chapter 29

BRIDGE MANAGEMENT

NDOT STRUCTURES MANUAL

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BRIDGE MANAGEMENT

29.1 PONTIS

29.1.1 General

PONTIS® is an AASHTO bridge management software package that relies upon collected condition data and cost data for bridge elements (e.g., girders, piers, railings). This data is analyzed to identify least-cost (optimal), long-term preservation and improvement policies for a network of bridges.

PONTIS can play a vital role in NDOT's asset-management process by allocating resources to preserve the existing infrastructure investment, ensure safety and maintain mobility. PONTIS stores inventory and inspection information on bridges, culverts and other structures in a relational database that supports modeling, analysis and reporting tools to facilitate project, budget and program development. PONTIS can assist in the formulation of network-wide preservation and improvement policies for use in evaluating the needs of each structure in the network, and it can make project recommendations for the NDOT program of capital projects. It also can analyze the impact of various project alternatives on the performance of individual structures or a network of structures.

29.1.2 NDOT Status

NDOT has been a subscriber to PONTIS since 1996. NDOT currently uses PONTIS to warehouse the State's NBI data and to collect and store all element-level bridge inspection data. To implement a formal bridge management system, NDOT must take the following steps:

- Refine the list of bridge elements, condition state definitions and environmental assignment policies.
- Incorporate additional data, such as Legal and Design standard data, Improvement cost data, User cost data and Preservation cost data.
- Develop preservation policies.
- Develop programming scenarios (e.g., Budget sets, Agency policy rule sets, Scenario cost and time thresholds).
- Model the development and validation of PONTIS.
- Implement project planning and development.

29.1.3 The Bridge Management Process

The PONTIS bridge management process begins with the building of a relational database that includes importing NBI data and adding element-level inspection information. The process continues with the development of a preservation policy for each element and environmental combination in the database. PONTIS performs a network analysis to identify needs and benefits and to support the allocation of resources for the development of specific preservation

and improvement program recommendations. From these recommendations, engineers and managers can use the Project Planning module to identify an initial program of work. The PONTIS bridge management process also includes tools for refining results, incorporating agency business practices, and allowing project tracking through the database.

29.1.4 Elements

The concept of bridge elements is the foundation of the PONTIS Bridge Management System. PONTIS uses element-level inspection data as the basis for bridge preservation analyses. The main components of a typical bridge (e.g., deck, superstructure, substructure) are subdivided into numerous elements to add more detail and precision. A superstructure might contain several elements such as concrete girders, concrete bridge deck, bearings, etc. Elements are also classified by material types (e.g., concrete, steel, timber). Through element-level inspections, NDOT quantifies the condition of structures. Each bridge element is assigned an element number and a description. The unit quantity for an element is placed in a Condition State. There are up to five available Condition States, 1 to 5 for an element. Condition State 1 is the best possible. PONTIS uses this information to compute the costs and benefits of bridge preservation. All of NDOT's bridges can be defined from a set of commonly recognized, or CoRe, elements as defined by AASHTO. See the AASHTO *Guide for Commonly Recognized (CoRe) Structural Elements*. Element level data is provided in accordance with procedures outlined in the "NDOT PONTIS Coding Guide" (see Appendix 29A).

29.1.5 Bridge Inspection

Bridge inventory and inspection data are managed using the PONTIS Inspection module. This consists of a set of relational tables and graphical user interfaces for creating new structures, deleting structures, reviewing existing data, entering new inspection data with comments, or checking data out of or into the system. This is a highly customizable data structure that includes the required National Bridge Inventory data, detailed element-level condition inspection data and custom agency data. The user may use the following programs within the Inspection module for a bridge, a group of bridges or all bridges in the database:

1. Translator. This functionality is not used by NDOT. NDOT conducts both NBI and PONTIS element level inspections, thus inputting codes for NBI Items 58 through 62. Translator is embedded in the PONTIS software and can convert the AASHTO CoRe Structural Elements information to the NBI condition codes, Items 58, 59, 60 and 62. FHWA will accept the results of Translator into the National Bridge Inventory.

2. Sufficiency Rating. This program calculates the Sufficiency Rating, Structure Evaluation Rating, Deck Geometry Rating, Vertical and Horizontal Rating and Structurally Deficient or Functionally Obsolete status.

3. Validation. This program uses the FHWA Edit Update Program to perform data validation checks of the most recent NBI data. Validation results display the Bridge ID, FHWA Error ID, Error Severity and Validation Message.

PONTIS uses the most recent data from the Inspection module to determine network-level and bridge-level preservation and improvement needs.

Chapter 28 discusses the Nevada Bridge Inspection Program.

29.1.6 Preservation and Improvements

PONTIS makes a distinction between preservation actions and functional improvements. Preservation actions seek to maintain or restore the physical condition of structure elements. Improvement actions are intended to improve the structure to satisfy the current and future functional demands. Preservation actions include maintenance, repair, rehabilitation or replacement of elements or groups of elements. The preservation model identifies the optimal preservation actions based on the objective of minimizing costs. Standard types of functional improvement actions include bridge widening, raising the bridge, strengthening and replacement. Programming of improvement actions is based on policy standards (e.g., lane and shoulder widths, vertical and horizontal clearances, unit costs and benefits supplied by the user). PONTIS is designed to support the testing of different combinations of functional improvement policies and cost-and-benefit assumptions. PONTIS analyzes preservation and improvement alternatives separately and incorporates them into a network analysis.

29.1.7 Network Level Analysis

A PONTIS simulation models a recommended bridge program for a network of bridges based on a set of scenario parameters. Scenario parameters include budgets, policies, costs and types of work. The goal of a simulation is to generate project alternatives for each bridge by maximizing benefits within a constrained budget. The competing alternatives are preservation, preservation plus improvement, replacement and user-defined projects. These are ranked and recommended for programming according to an incremental benefit-cost analysis. The results of a network-level analysis serve as a good starting point for the project development and programming process.

29.1.8 Project-Level Analysis

In the Project Planning module, the results of the network analyses and inspector work candidates are used to generate projects. Projects consist of specific work items on one or more bridges. Programs are developed from groups of projects for a specified period of time and types of work. The module includes a tool for running a single bridge simulation to evaluate the impact of a proposed set of actions before committing to a project. Projects are assigned to programs (e.g., Statewide Maintenance, Interstate Maintenance, Highway Bridge Program). Once a program has been developed, the network analysis can be rerun to further refine the results.

29.1.9 Reviewing and Refining Results

Three methods are available for reviewing the results of a PONTIS analysis. The Results module provides a report builder for needs, programmed work and performance measures for any network scenario. The Reports button provides access to additional reports, and the Work Candidates Panel in the Project Planning module provides details on scenario and inspector work candidate recommendations. By modifying scenario parameters for budgets, improvement policies and improvement costs, PONTIS refines the results to reflect agency business practices. Further refinements are made by defining Simulation Rules for scoping, look ahead for user programmed work and major rehabilitation. Preservation policies can be refined by creating and using the agency policy rules or by adjusting preservation model elicitations. Users may perform what-if analyses by running multiple scenarios to compare results for different combinations of parameters.

Appendix 29A

PONTIS CODING GUIDE

29A.1 Introduction

Appendix 29A presents a NDOT supplement to the AASHTO *Guide for Commonly Recognized (CoRe) Structural Elements* (the *Guide*) to assist the bridge inspector with the evaluation and coding of PONTIS "CoRe" (Commonly Recognized) and "Smart Flag" element Condition State Ratings. The PONTIS Condition State Ratings specified for each CoRe elements differ from the Numerical Condition Ratings (NCRs) used to encode bridge component data for the Bridge Inspection Report and for Items #58-62 of the Structure Inventory and Appraisal (SI&A) Report. PONTIS Element ratings are PONTIS-specific and follow specific Condition State definitions, which are provided for each CoRe and Smart Flag element. The *Guide* presents Condition State descriptions for CoRe elements and Smart Flags not specified herein. When encoding this PONTIS data, these definitions must be strictly followed.

For PONTIS to accurately model deterioration rates for a specific bridge, PONTIS bridge element data must be obtained during successive inspections gathered and encoded in a similar fashion. All inspectors must, therefore, follow the same conventions involving data acquisition and data entry. Specific conventions to be replicated involve unit of measurement assignment, girder tabulations and condition state assignment.

29A.2 Unit of Measurement Assignment Conventions

These conventions address the specific units of measurement that will be assigned to certain deficiencies as they occur in bridge elements that are rated per linear foot.

29A.2.1 Cracking

Regarding horizontal or diagonal cracking, the number of linear meters of the element affected by this cracking will be recorded, rounding up to the nearest meter. Regarding vertical cracking in an element, the inspector shall count the number of significant cracks (structural cracks, not including paint cracking) in the element, and assign one-half linear meter to each crack, provided that cracks are at a separation distance of greater than one-half meter. For cracks less than one-half meter apart, simply record the overall affected length of cracking, rounding up as appropriate. For map or alligator cracking, record the linear meters of the affected area, rounding up to the nearest meter.

Cracking in opposing sides of an element (e.g., cracking in opposite sides of a pier cap or pier wall) requires careful data recording, because PONTIS records only the physical length of most elements and not the cumulative length of all faces. Thus, cracking that occurs in opposite faces of a member, but occupies the same linear dimension along the member's length, will only be recorded as that affected length times a factor of one. If cracking occurs in opposite faces of a member and in different locations along the member's length, then the sum of both affected lengths should be recorded.

29A.2.2 Spalling/Scaling/Delamination

Spalling, scaling, delamination and other minor to moderate deterioration that occurs in an element will be assigned a minimum measurement of one-half meter of length for each area of damage, provided that such areas are more than one-half meter apart. For areas of deterioration measuring greater than one-half meter in length and for areas less than one-half meter apart, record the overall length of the affected area, rounding up to the nearest meter. Areas of deterioration occurring on opposite sides of a member shall be treated similarly to the cracking scenario discussed previously.

29A.2.3 Severe Damage/Deterioration

Bridge members that exhibit severe damage or deterioration, whether due to vehicular impact, chemical attack, flooding, settlement or any other cause, require considerable engineering judgment and common sense by the inspector. In evaluating a severely damaged AASHTO I-girder, for example, the inspector must either subdivide the length of the girder into various lengths meeting the criteria for Condition States 1, 2, 3 and 4, or determine that the entire girder requires replacement; in this case, its entire length should be placed into Condition State 4.

In most cases, for members that have sustained damage sufficiently severe to require replacement and members that have failed, their entire lengths (or per each unit) shall be rated in the lowest condition state rating available. The subdivision of lengths into various condition states will typically be relegated to those members exhibiting repairable damage. If there is uncertainty when rating severe damage, seek the advice of experienced individuals.

29A.2.4 Affected Length of Arch/Truss Member Deficiencies

All measurements for deterioration in arch or truss members shall be the measurement of the affected length along the horizontal projection of the arch or truss. See Figure 29A-2 for a sample illustration.

29A.3 Girder Tabulation Conventions

Another important convention is the tabulation on the number of individual girders present on a given bridge. In general, girder tabulation will follow the format presented in Figure 29A-1.

Where two or more different types of girders exist in the same bridge, the total number of girders for each separate type shall be tabulated and rated independently, following the format presented in Figure 29A-2. For additional information, consult the specific PONTIS CORE elements for open and box girders from the element listings in Sections 29A.5.3 and 29A.5.4.

29A.4 Condition State Assignment Conventions

The assignment of various condition states to a bridge element often requires considerable engineering judgment and an adherence to the exact condition state definitions (as listed in the *Guide*) for that element.

The following sections provide NDOT's conventions for the coding of condition states for the various PONTIS CoRe and Smart Flag bridge elements.

Note: In general, the "number of girders" in the PONTIS inventory for a bridge can be determined from the number of girders that are visible to the engineer during a field investigation. See the following examples.

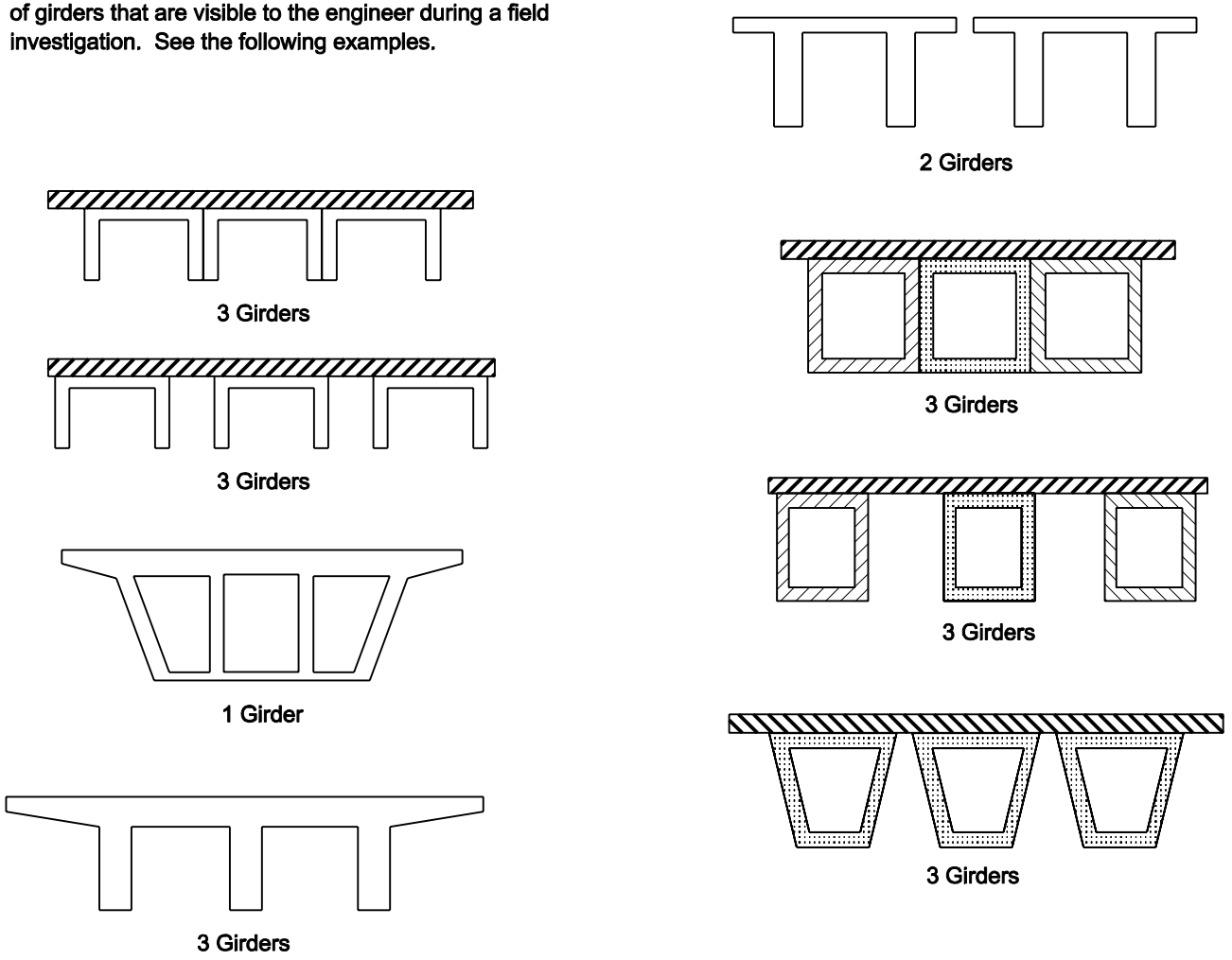
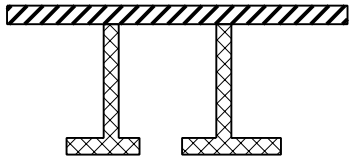
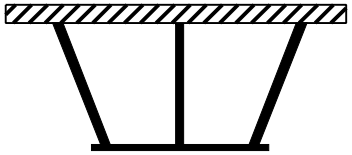


Figure 29A-1— CONVENTIONS FOR PONTIS

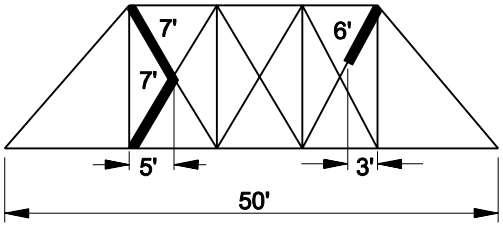


2 Girders



1 Girder

Truss and Arch Measurements



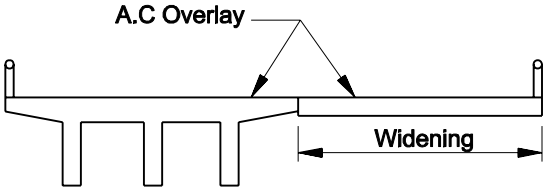
Deteriorated Parts of Truss

All measurements of a truss are along the horizontal projection, including the deterioration measurements. The total length of the above truss is 50' while the recorded length of the deteriorated part of the truss is equal to 8' (5' + 3').

The convention used for a spandrel arch will be similar to that used for a truss.

The unit for coding the Deck/Slab PONTIS bridge elements is "EACH". Thus, when the bridge has one Deck/Slab type, the quantity is 1 (It does not matter how many spans there are). However, when the same bridge has two different types of Deck/Slab types (Example: Elements 13 and 39), record the quantity equal to 1 for each element.

Example:



Typical Section

Elem. No.	Description	Quantity	Unit
13	Concrete Deck (AC)	1	Ea
39	Concrete Slab (AC)	1	Ea

In addition to the other substructure, superstructure and miscellaneous elements.

Figure 29A-2 — CONVENTIONS FOR PONTIS

29A.5 Core Bridge Elements

29A.5.1 Deck, Element Nos. 12-32, Rating Units: Ea

This element shall be used to provide PONTIS ratings for the bridge deck and/or deck surface covering, if present. Rating criteria specific to different deck material types is:

1. Concrete Deck (Element Nos. 12-27). For bridges using a concrete deck, the condition states reference only deficiencies in the deck surface. Specifically, PONTIS references only repaired areas; potholes and impending potholes for decks with asphalt overlays; adding spalls and delaminated areas as viable deficiencies in bare decks; and decks either covered with thin or rigid overlays or protected with epoxy-coated bars or cathodic protection. These deficiencies will be rated based upon their combined area of distress as a percentage of deck area, as outlined in the condition state descriptions.

   The Smart Flag "Deck Cracking" (Element No. 358) will be used to rate cracking in the deck. Condition state descriptions for this element, as illustrated in both the PONTIS program and PONTIS *User's Manual*, are self-explanatory. When deficiencies more significant than cracking begin to appear in the deck, the use of this Smart Flag should be discontinued.

   The Smart Flag "Soffit" (Element No. 359) may be used to rate deck distresses visible in the underside of a concrete deck as a result of internal corrosion. Further, "Soffit" may be used to rate deck distresses evident when the surface of the deck is covered with an overlay and, thus, is not visible.

   A problem arises when the deck top of a structure is covered with an overlay, and the entire deck underside is also hidden from view via stay-in-place formwork. In this case, one can only rate the condition of the deck surfacing using standard condition state descriptions.

2. Steel Deck — Open/Concrete Filled Grid (Element Nos. 28-29). These elements provide PONTIS ratings for the condition of the entire steel deck and all connection devices (e.g., welds, rivets). Condition state conditions for these elements are self-explanatory.

3. Deck — Corrugated/Orthotropic/etc. (Element No. 30). This element is used to provide PONTIS condition ratings for concrete-filled corrugated metal decks or orthotropic decks. Orthotropic decks are often found in Nevada on railroad bridge structures. Condition state definitions for this element are self-explanatory.

4. Wood Deck — Bare or Overlaid (Element Nos. 31-32). These elements are used to provide PONTIS ratings for the condition of all surfaces of timber bridge decks, whether bare or overlaid with an asphalt surfacing. Condition state definitions are self-explanatory.

5. Combination Deck/Slab Types. For bridges constructed using two or more different types of deck or slab construction, each deck/slab type should be documented and rated independently, using the appropriate condition state definitions.

29A.5.2 Slabs, Element Nos. 38-55, Rating Units: Ea

These elements will be used to provide PONTIS ratings for the condition of deck slabs constructed of either concrete or timber. Evaluation criteria for these materials is essentially identical to that previously presented for concrete and timber bridge decks. Smart Flags "Deck Cracking" (Element No. 358) and "Soffit" (Element No. 359) may be used for concrete slabs as previously described.

Combination slab/deck types should be documented and rated independently, as previously described under "Combination Deck/Slab Types."

29A.5.3 Closed Web/Box Girder, Element Nos. 101-105, Rating Units: Meter

This element will be used to provide PONTIS ratings for the condition of box girders constructed of steel, conventionally reinforced concrete or prestressed concrete.

The total number of linear meters of box girder to be entered into PONTIS as "Total Quantity" shall be the total number of girders multiplied by total linear meters of each. The number of girders shall be determined by following the girder measurement conventions as shown in Figures 29A-1 and 29A-2. In general, precast box girders placed side-by-side shall be counted as one per individual box; a cast-in-place box girder, which may contain several internal cells, shall be counted as only one girder. When precast girders exist alongside a cast-in-place box girder (as in many widened bridges), the total linear meters of each box girder type shall be calculated, then the subtotals merged, if of common element type (i.e., both prestressed).

The total number of linear meters shall be subdivided into different condition states following the specific condition state definitions for that element. Condition state definitions for closed web/box girder elements are self-explanatory.

29A.5.4 Open Girder, Element Nos. 106-111 (Excluding 108), Rating Units: Meter

These elements shall be used to provide PONTIS ratings for the condition of open girders constructed of steel, conventionally reinforced concrete, prestressed concrete or timber.

The total number of linear meters of open girder to be entered into PONTIS as "Total Quantity" shall be the number of girders multiplied by the number of linear meters of each. The total number of linear meters shall be subdivided into different condition states following the specific condition state definitions for that element. Condition state definitions for open girder elements are self-explanatory.

Unlike the SBIS inspection reporting methodology, multiple open-girder types co-existing on the same bridge will all be rated as open girders, and not girders and stringers. Different open girder types shall simply be subdivided into their proper open girder element numbers and be rated therein.

29A.5.5 Railroad Car Girder, Element No. 108, Rating Units: Meter

This element, specifically adopted by NDOT, will be used to provide PONTIS ratings for the condition of railroad flatcar "girders," which act as superstructures for many rural Nevada bridges. These girders, most often constructed of painted steel, will be rated using the painted steel condition state descriptions provided for Element No. 107 "Painted Steel Open Girder."

This element will be rated in linear meters (no. girders x no. linear meters each = "Total Quantity"), with an entire, singular flatcar considered as one girder. Where multiple, side-by-side flatcars make up a bridge deck, each flatcar shall be considered a separate girder.

29A.5.6 Stringer, Element Nos. 112-117, Rating Units: Meter

These elements shall be used to provide PONTIS ratings for the condition of stringers constructed of steel, prestressed concrete, conventionally reinforced concrete or timber. For PONTIS purposes, stringer elements will include only those members (typically longitudinal in orientation) that support the deck in true stringer-floor beam systems. Superstructure members of longitudinal orientation that do not juncture with floor beams will usually be classified as "Open Girders."

Stringers will be rated in linear meters, with "Total Quantity" calculated by multiplying the total number of stringers of given type by the total linear meters of each. Stringers of different type will be subdivided into different element numbers and rated therein, using the appropriate condition state definitions. Condition state definitions for stringers are self-explanatory.

29A.5.7 Steel Truss Members, Element Nos. 120-130, Rating Units: Meter

These elements shall be used to provide PONTIS ratings for the condition of steel truss members. All members will be rated in linear meters, measured along the horizontal projection of the span, as shown in Figure 29A-2.

Steel truss members will be rated using the condition state definitions of the appropriate element number. All definitions are self-explanatory.

29A.5.8 Timber Truss/Arch, Element No. 135, Rating Units: Meter

This element will be used to provide PONTIS ratings for the condition of all members of truss and arch structures that are constructed of timber. All members will be rated in linear meters, measured along the horizontal projection of the span, as with steel truss members. Condition state definitions for this element are self-explanatory.

29A.5.9 Arch, Element Nos. 140-145, Rating Units: Meter

These elements will be used to provide PONTIS ratings for the condition of arches constructed of steel, prestressed concrete, conventionally reinforced concrete or masonry. All arch members will be rated in linear meters, measured along the horizontal projection of the span, as with truss members. Condition state definitions for arch members are self-explanatory.

29A.5.10 Cable (Not Embedded in Concrete), Element Nos. 146-147, Rating Units: Ea

These elements will be used to provide PONTIS ratings for the condition of coated and uncoated metal cables (e.g., main and suspender cables of suspension bridges, hangers of tied arches, cables of cable-stayed bridges). Cables will be rated as "each" (or each cable of a system) and will use a unique set of condition state definitions that evaluates the cable itself,

including cable banding and anchorages. Element No. 147 also evaluates the condition of the protective cable coating.

29A.5.11 Floor Beam, Element Nos. 151-156, Rating Units: Meter

These elements will be used to provide PONTIS ratings for the condition of floor beams constructed of steel, conventionally reinforced concrete, prestressed concrete and timber. These elements will be used to rate stand-alone floor beams and floor beams used in stringer/floor beam systems.

Floor beams will be rated in linear meters with "Total Quantity" calculated by multiplying the number of floor beams times the linear meters of each. Condition state definitions for use in the breakdown of total linear meters into various condition states are standard for the various material types and are self-explanatory.

29A.5.12 Pin-and-Hanger Assembly, Element Nos. 160-161, Rating Units: Ea

These elements will be used to provide PONTIS ratings for the condition of steel pins and/or pin-and-hanger assemblies used in bridge superstructures. Examples include pin connections in trusses and pin-and-hanger assemblies in girders. Pins used in bearing assemblies must not be rated with these elements but, rather, as bearings. Pins and pin-and-hanger assemblies must be rated per each using the appropriate condition state descriptions, which are self-explanatory.

29A.5.13 Column or Pile Extension, Element Nos. 201-206, Rating Units: Ea

These elements will be used to provide PONTIS ratings for the condition of piles or columns constructed of steel, conventionally reinforced concrete, prestressed concrete or timber.

When rating piles or columns only, the portions of each member that are clearly visible above the groundline will be rated. The underground portions of each are assumed to be in good condition (Condition State 1) if no visible distress exists in the member that can be directly attributed to an underground deficiency in that member.

Columns and piles will be rated per each, in accordance with the appropriate condition state definitions, which are self-explanatory. For structures using more than one type of pile or column, group each type of member into its proper element number and rate therein.

29A.5.14 Pier Wall, Element Nos. 210-211, Rating Units: Meter

These elements will be used to provide PONTIS ratings for the condition of pier walls or shafts constructed of either reinforced concrete or any "other" material (e.g., masonry, concrete-filled steel sheet piling).

A distinction is necessary between what constitutes a pier wall vs a column. Much of this decision lies with the judgment of the inspector, because no clear-cut formal distinctions have been made in the bridge inspection training literature. However, columns are rated per each, but pier walls are rated per linear meter. Therefore, it may benefit the inspector to rate as pier walls those members that can easily be subdivided and rated on a per-linear-meter basis.

Members with clearly definable long and short faces, whether flared or straight, shall usually be termed pier walls for PONTIS.

Pier walls shall be rated following the condition state definitions for either “Reinforced Concrete” or “Other.” Both sets of definitions are self-explanatory.

29A.5.15 Abutment, Element Nos. 215-217, Rating Units: Meter

These elements will be used to provide PONTIS ratings for the condition of bridge abutments constructed of either reinforced concrete, timber or any “other” suitable material (e.g., masonry, concrete-filled steel sheet piling).

For PONTIS, abutments will be rated in linear meters along the length of the stem wall (and/or backwall) portions only. PONTIS does not incorporate the wingwalls or retaining walls constructed adjacent to each abutment. For widened bridges, simply measure the new overall stem wall face widths, from outer edge of abutment to outer edge of abutment.

The condition state definitions for abutments are standard for the various material types and are self-explanatory.

29A.5.16 Submerged Pile Cap/Footing, Element No. 220, Rating Units: Ea

This element will be used to provide PONTIS ratings for the condition of reinforced concrete footings, whether or not supported by foundation (bearing) piling. Those footings that use foundation piling act as submerged pile caps, thus, contributing to the element name. All footings will be lumped into this element.

Footings will be rated per each, following the condition state definitions provided. Footings that are buried at the time of inspection will be placed into Condition State 1, unless there exists some above-ground condition indicative of underlying footing distress. In this case, the footing rating will be left to the discretion of the inspector. At this point, the inspector should also decide if further investigation is warranted.

29A.5.17 Submerged Pile, Element Nos. 225-228, Rating Units: Ea

These elements will be used to provide PONTIS ratings for the condition of submerged foundation piling, whether constructed of steel, prestressed concrete, conventionally reinforced concrete or timber. Foundation (bearing) piles will be rated in this element whether submerged or partially visible at the time of inspection.

Foundation piles that are buried at the time of inspection shall be placed into Condition State 1, unless there exists some above-ground condition indicative of underlying distress to the piling. In this case, the submerged pile rating will be at the discretion of the inspector. At this point, the inspector should also decide if further investigative action is warranted. Submerged piles will be rated per each using the appropriate condition state definitions, which are self-explanatory.

29A.5.18 Cap, Element Nos. 230-235, Rating Units: Meter

These elements will be used to provide PONTIS ratings for the condition of pier, bent or abutment caps constructed of steel, conventionally reinforced concrete, prestressed concrete or timber.

Caps will be rated in linear meters of length (number of caps multiplied by meters of length each = "Total Quantity") using the appropriate condition state definitions, which are self-explanatory. Bridges constructed using caps of differing materials should have those caps subdivided into proper element numbers by material type.

29A.5.19 Culvert, Element Nos. 240-243, Rating Units: Meter

These elements will be used to provide PONTIS ratings for the condition of box, arch and pipe culvert structures, constructed of metal, concrete, timber or any other suitable material. The Steel Culvert Element (No. 240) includes all metal types including steel, aluminum and galvanized materials. Additionally, the Concrete Culvert Element (No. 241) includes both conventionally reinforced and prestressed concrete materials, and the Other Culvert Element (No. 243) will include masonry and combinations of other materials.

Culverts will be rated on a linear meter basis, with the "Total Quantity" measurement encompassing the total length of all barrels combined (number of barrels multiplied by length of each). Deficiencies common to more than one barrel (e.g., through-cracking in barrel sidewalls) will be rated as occurring in each barrel affected.

Condition state definitions for use in rating culvert elements are self-explanatory.

29A.5.20 Expansion Joints, Element Nos. 300-304, Rating Units: Meter

These elements will be used to provide PONTIS ratings for Strip Seal Expansion Joints (Element No. 300), Pourable Joint Seals (Element No. 301), Compression Joint Seals (Element No. 302), Assembly (Modular) Joint Seals (Element No. 303) and Open Expansion Joints (Element No. 304). The intended use of Element Nos. 300, 301, 302 and 304 are self-explanatory, as are their respective condition state definitions.

In contrast, the intended usage of Element No. 303 "Assembly (Modular) Joint Seal" is somewhat vague. This element will be used to rate mechanical expansion joints, including sliding plate joints, fingerplate joints and modular elastomeric seals. Condition state definitions for this element are self-explanatory.

Rate expansion joints filled with only fiberboard "bond breaker" material (i.e., no poured sealant) as open expansion joints.

All expansion joints are rated in linear meters, with the total linear meters of all joints of similar type being recorded as the "Total Quantity" of each element.

29A.5.21 Bearings, Element Nos. 310-315, Rating Units: Ea

These elements will be used to provide PONTIS ratings for Elastomeric Bearings (Element No. 310), Moveable Bearings (Element No. 311), Enclosed/Concealed Bearings (Element No. 312), Fixed Bearings (Element No. 313), Pot Bearings (Element No. 314) and Disc Bearings (Element

No. 315). The intended use of Element Nos. 310-311 and 313-315 are self-explanatory, as are their respective condition state definitions.

In contrast, the intended use of Element No. 312 "Enclosed/Concealed Bearing" requires clarification. This element shall be used to rate bearings that are partially or completely hidden from view, thus compromising the physical inspection of the bearing member itself. An example of enclosed/concealed bearings might be a series of elastomeric bearing pads, used to support a prestressed box girder, and recessed far enough back upon the abutment bridge seat to be almost out of view.

The rating of such bearings comprises an evaluation of the bearing itself (as possible) and an evaluation of the bearing support and supported members, including noting excessive vertical and horizontal offsets and examining their structural condition and any movement under live loading.

Bearings are rated per each, with differing bearing types being subdivided and rated according to their proper element condition state definitions.

29A.5.22 Approach Slab, Element Nos. 320-321, Rating Units: Ea

These elements will be used to provide PONTIS ratings for the condition of approach slabs constructed of either conventionally reinforced or prestressed concrete. In Nevada, approach slabs are typically constructed using conventionally reinforced concrete (Element No. 321).

Approach slabs are rated per each (per individual slab) using the condition state definitions, which are self-explanatory.

29A.5.23 Bridge Railing, Element Nos. 330-333, Rating Units: Meter

These elements will be used to provide PONTIS ratings for the condition of bridge railings constructed of metal (all types and shapes), concrete, timber and miscellaneous (other) materials.

Element No. 333 "Miscellaneous – Bridge Railing" will be rated for all rail types and shapes other than metal, concrete or timber, and it includes those rails constructed using combinations of materials. An example of a combination rail is a rail constructed using timber posts and steel railing panels.

Bridge rails constructed using a metallic rail (e.g., tubular aluminum) mounted atop a concrete parapet shall be encoded listing both Element No. 330 (Metal Bridge Railing) and Element No. 331 (Concrete Bridge Railing), with the appropriate length of each type listed under "Total Quantity."

Bridge railing total quantities will be subdivided into various condition states using the appropriate condition state definitions, which are self-explanatory.

29A.6 Smart Flags

29A.6.1 Steel Fatigue, Element No. 356, Rating Units: Ea

This element will be used to provide a rating for fatigue damage to a particular bridge. This smart flag shall be encoded only for those bridges where fatigue damage is known to exist.

Fatigue damage that has been repaired or arrested shall be placed into Condition State 1. First-time fatigue damage and newly documented additional fatigue damage shall be placed into Condition State 2. Fatigue damage severe enough to warrant analysis of the element to ascertain its serviceability shall be placed into Condition State 3. Rating is per each (per bridge).

29A.6.2 Pack Rust, Element No. 357, Rating Units: Ea

This element will be used to provide a rating for pack rust (impacted crevice corrosion) that already exists in a bridge. This element addresses crevice corrosion in steel connections and built-up members and rates the severity of resulting distress to that connection.

This element follows a set of self-explanatory condition state definitions and is rated per each (per bridge).

29A.6.3 Deck Cracking, Element No. 358, Rating Units: Ea

This element will be used to provide a rating for cracking that occurs in the deck surface of a bridge. This smart flag will typically be rated for those structures that exhibit deck cracking, but do not as yet exhibit the more significant deficiencies listed in the deck and slab core element condition state definitions (e.g., spalling, potholes, delaminated areas, repaired areas). Where these deficiencies exist, the use of the deck cracking smart flag should be discontinued.

A distinction is necessary between Condition States 2 and 3 for this element. Condition State 2 should be used to rate deck cracks that are moderate in either size or density (frequency of occurrence). Condition State 3 should be used when deck cracks are of moderate size and moderate density. Condition States 1 and 4 definitions are self-explanatory. This element is rated per each (per bridge).

29A.6.4 Soffit, Element No. 359, Rating Units: Ea

This element will be used to provide a rating for distresses visible in the underside of a deck or slab, primarily attributable to active corrosion within the member. This element should be rated when possible for bridges with a deck that is covered with an overlay. A soffit may, however, be rated at any time its inclusion into PONTIS is deemed useful to describe deterioration in the deck not reportable by other means.

This element is rated per each (per bridge) and uses a set of condition state definitions that are self-explanatory.

29A.6.5 Settlement, Element No. 360, Rating Units: Ea

This element will be used to provide a rating for substructure settlement (e.g., vertical settlement, rotation) found to exist at a bridge and to provide some measure of the magnitude of that settlement. This element is rated per each (per bridge).

This element uses only three condition states to rate settlement. Condition State 1 should be rated when visible settlement exists in the substructure and it appears to have stabilized. Condition State 2 rates settlement that appears to be continuing and could potentially cause problems if left unarrested. Settlement documented for the first time will usually be placed into Condition State 2, unless of a very minor nature. Condition State 3 should be used to rate severe settlement that threatens the integrity of the bridge to the extent that structural analysis is warranted.

29A.6.6 Scour, Element No. 361, Rating Units: Ea

This element will be used to provide a rating for scour at a bridge and to provide a measure of the magnitude of that scour. This element is rated per each (per bridge).

This element uses three condition states to rate bridge scour. Condition State 1 should be rated to document minor scour, but which is of little concern to the structural integrity of the bridge. Condition State 2 should be rated to document scour that could potentially threaten the structural integrity of the bridge if left unchecked. Pier or abutment scour that is documented for the first time and is found to have exposed portions of the footing of that element should be placed in Condition State 2. Additionally, previously documented scour that is found to be increasing in magnitude should be placed in this condition state. Condition State 3 will be used to document scour that is severe enough to warrant analysis of the bridge.

29A.6.7 Traffic Impact, Element No. 362, Rating Units: Ea

This element will be used to provide a rating for distress to any bridge element caused by traffic impact. This smart flag will primarily address superstructure damage caused by vehicular impact (high load hits). This element is rated per each (per bridge).

This element uses three condition states to rate traffic impact damage. Condition State 1 identifies impact damage that has been repaired. Condition State 2 will be used to document damage that has not been repaired and does not threaten the serviceability of the bridge. Condition State 3 should be rated to document damage that has impaired the strength of the impacted member, warranting analysis to determine the serviceability of the bridge.

29A.6.8 Section Loss, Element No. 363, Rating Units: Ea

This element will be used to provide a PONTIS rating for measurable loss of section experienced by a bridge element. Although most commonly associated with steel, this element could also be applied to section loss in elements composed of timber or even concrete. This element is rated per each (per bridge), and condition state definitions are self-explanatory.

Note that Condition State 1 is reserved for section loss that has been either repaired or cleaned and painted over. Measurable section loss documented for the first time, therefore, will be placed into Condition State 2, at a minimum.