To:		New York State Department of Transportation **ENGINEERING INSTRUCTION**	**EI** **05-034**
Title: LOAD RATING/POSTING GUIDELINES FOR STATE-OWNED HIGHWAY BRIDGES			
Distribution: ❑ Manufacturers (18) ❑ Surveyors (33) ☒ Local Govt. (31) ☒ Consultants (34) ☒ Agencies (32) ❑ Contractors (39) ❑ ____________( )	Approved: /s/ G. A. Christian 10/18/05 George A. Christian, Date Deputy Chief Engineer (Structures)		

ADMINISTRATIVE INFORMATION:

- Effective Date: This Engineering Instruction (EI) is effective upon signature.
- Superseded Issuances: The Information transmitted by this EI supersedes Engineering Instructions 88-004, 88-005, 88-006, and 94-004.
- Disposition of Issued Materials: The information included in this EI is intended to stand alone outside of any other document.

PURPOSE: To issue guidance for prioritizing and submitting load rating calculations, posting bridges for load restrictions, and documenting and reporting load tests on state-owned highway bridges.

TECHNICAL INFORMATION: The language used in this EI to describe personnel, entities and functions is in accordance with NYSDOT's present organizational structure, with the anticipated Program Support Division organizational entity in parenthesis where appropriate.

1) INTRODUCTION

Bridge load rating is the determination of the live load carrying capacity of a newly designed or existing bridge. Load ratings are typically determined by analytical methods based on information taken from bridge plans supplemented by information gathered from field inspections or field testing. This task is vital for several reasons, including (but not limited to) the following:

- To determine which structures have substandard load capacities that may require posting or other remedial action.
- To assist in the most effective use of available resources for rehabilitation or replacement.
- Mandated by the Code of Federal Regulations – Highways, Title 23. Chapter 1 – Federal Highway Administration (FHWA), DOT, Part 650 – Bridges, Structures and Hydraulics.
- Mandated by New York State Highway Law, §230, §231, §232, & §233. NY Code of Rules and Regulations, 17 (17NYCRR), Chapter V – Uniform Code of Bridge Inspection (UCBI).
- To assist in the overload permit review process.

The New York State regulations regarding bridge load ratings are part of the UCBI, which is contained in the current NYSDOT Bridge Inspection Manual.

The Federal Highway Administration (FHWA) requires that bridge load rating results be submitted to them annually. These results are used in conjunction with other bridge inventory and inspection information to determine the Federal Bridge Sufficiency Rating, which, in turn, is a factor used to determine the eligibility of a project for the Highway Bridge Replacement and Rehabilitation (HBRR) Program. Inaccurate bridge ratings may result in incorrect eligibility determinations under the program. This document provides guidance for prioritizing and submitting load rating calculations, posting bridges for load restrictions, and documenting and reporting load tests.

1.1 DEFINITIONS and TERMINOLOGY:

AASHTO - American Association of State Highway and Transportation Officials.

AASHTO Manual - AASHTO Manual for Condition Evaluation of Bridges (MCEB). In 2006 the MCEB will be replaced by the Manual for Evaluation of Bridges.

BDMS - Bridge Data Management System.

FHWA - Federal Highway Administration, U.S. Department of Transportation.

Internally Redundant - Supporting primary members made up of three or more elements that are mechanically fastened together so that if one should fail the other elements will be able to internally transfer the load and still support the main structure. An example would be a riveted girder.

Inventory Rating Level - The inventory rating level generally corresponds to the customary design level of stresses but reflects the existing bridge and material conditions with regard to deterioration and loss of section. Load ratings based on the inventory level allow comparisons with the capacity for new structures and, therefore, results in a live load which can safely utilize an existing structure for an indefinite period of time. (MCEB)

Limit State - A condition beyond which the bridge or component ceases to satisfy the criteria for which it was designed.

Load Effect - The response (axial force, shear force, bending moment, etc.) in a member or an element due to externally applied loads.

Load Factor - A load multiplier accounting for the variability of loads, the lack of accuracy in analysis, and the probability of simultaneous occurrence of different loads.

Load Path Redundant - A structure that has multiple paths between substructure units to distribute the load in the event of failure of one of the supporting members. Examples are steel multi-girder or prestressed concrete multi-girder bridge types. NYSDOT considers a structure to

be load path redundant if it has four or more load paths.

Load Posting - Live load weight restriction placed on a structure, by the owner, when a bridge is incapable of carrying the maximum legal live load. Load postings are done after an analysis that accounts for the current condition of the structure.

Load Rating Engineer (LRE) - Engineer responsible for the accuracy and quality control of load rating data for a given bridge inventory in accordance with this EI, State and Federal requirements.

Load Rating Levels - Bridge load ratings in New York State are grouped into three distinct levels of accuracy, Level 1, Level 2, and Level 3. Load Rating Levels are discussed in detail in subsequent sections.

Load Rating Unit - Functional unit responsible for statewide implementation, operations, and quality assurance of the NYSDOT load rating program, including management of the Statewide load rating database.

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.

Operating Rating Level - Load ratings based on the operating rating level generally describe the maximum permissible live load to which the structure may be subjected. Allowing unlimited numbers of vehicles to use the bridge at operating level may shorten the life of the bridge (MCEB).

Quality Assurance - The use of sampling to verify or measure the level of the entire bridge inspection and load rating program.

Quality Control - System that is intended to maintain the quality of a bridge inspection and load rating at or above a certain level.

R-Posting - A load restriction for a bridge, which based on design or condition, does not have the reserve capacity to accommodate most vehicles over legal loads but, can still safely carry legal loads. Vehicles operating pursuant to an overweight permit with structure use restrictions (known as "R" Permits) are not allowed to cross. Originally established for NYSDOT's divisible load permit program, R-Postings are also used to restrict other non-divisble overload permit classifications. These bridges are identified with signage stating "No Trucks with R Permits."

Resistance Factor - A resistance multiplier accounting for the variability of material properties, structural dimensions, workmanship, and the uncertainty in the prediction of resistance.

Serviceability - A term that denotes restrictions on stress, deformation, and crack opening under regular service conditions.

Service Limit State - Limit state relating to stress deformation and cracking.

Strength Limit State - Safety limit state relating to strength and stability.

Substantial Structural Alteration - Any work that modifies the live load capacity, load distribution or load paths or structural behavior of the bridge (UCBI).

UCBI - Uniform Code of Bridge Inspection - NY Code of Rules and Regulations, 17, Chapter V.

2) LEVEL 1 LOAD RATING GUIDELINES

2.1 INTRODUCTION:

"A Level 1 rating refers to any fully documented analysis or capacity evaluation that is signed and certified by a professional engineer, licensed by the State of New York, as being complete and correct in its computation of bridge load capacity. Generally, a Level 1 analysis shall be in conformance with the analysis assumptions and provisions of the AASHTO Manual." – UCBI 165.8 (a) (1). Rating results from Level 1 calculations are used to determine need for member strengthening, load posting, or if a structure should be closed.

A complete Level 1 load rating will include analyses of the following items:

- All elements defined as "primary members" in the NYSDOT Bridge Inspection Manual, as well as all stringer-floorbeam, girder-floorbeam, and truss connections.
- Timber and metal bridge decks.
- Timber and metal pier elements.

It is not necessary to analyze concrete bridge decks, concrete and masonry substructure elements, or foundation elements unless there are unusual circumstances which, in the load rating engineer's judgment, will affect the load carrying capacity of the bridge. Secondary members subject to impact damage or deterioration shall also be investigated if the capacity of a primary member is affected.

Level 1 load ratings are required for all new and replacement bridges, and for all rehabilitation and repair designs involving a substantial structural alteration. Level 1 rating calculations shall be performed as part of the structural analysis process used for design and reflect the bridge as-built or as-rehabilitated construction and configuration. As an example, a new bridge design will account for a future wearing surface, but the Level 1 load rating does not include this future wearing surface as a dead load because it is not part of the as-built condition. This rule also applies to a Level 2 analysis which accounts for the current conditions of the structure.

Ratings shall be calculated following the guidelines contained in the latest edition of the AASHTO Manual adopted by NYSDOT.

2.2) ANALYSIS FREQUENCY:

Level 1 calculations eventually become outdated. Member deterioration, rehabilitation, redecking, and repaving of the wearing course are just a few of the occurrences that may force a reanalysis of the bridge. Therefore, the required frequency of Level 1 calculations can vary

widely. A new bridge designed to current standards may not need another Level 1 for some time if it is maintained properly. However, for example, an old truss that is deteriorating steadily should be reanalyzed as conditions change every few years.

The Load Rating Engineer (LRE) or other qualified person should review any existing Level 1 data during or after each inspection to see if a reanalysis is needed. A new Level 1 analysis may be necessary if any of the following have occurred since the last Level 1 analysis was completed.

- The primary member condition rating on the inspection report has changed by more than one point, if the initial rating was 5 or lower.
- Dead load has changed significantly due to resurfacing or other nonstructural alterations.
- Section properties have changed due to rehabilitation, redecking, deterioration, or other alterations.

If Level 1 load ratings stored in NYSDOT's statewide database are invalid, these ratings shall be deleted from the database by the LRE or other designated qualified personnel.

The Priorities for Level 1 analysis may be set in the following order:

1. Bridges which appear to require R posting or load posting.
2. Bridges with primary member ratings less than 4 (using NYSDOT's 1-7 rating scale) that are not ratable by NYSDOT's standard load rating system.
3. Bridges that are ratable by NYSDOT's standard load rating system with primary member ratings less than 4.

2.3) DOCUMENTATION AND SUBMISSIONS:

All Level 1 calculations must be certified as accurate by a professional engineer currently licensed in New York State. They must be performed and checked according to standard structural engineering practice. If using a computer program, note the program name and version. Also, all input information must be documented. Both Allowable Stress and Load Factor are acceptable analysis methods but, Load Factor is the preferred rating method. Load ratings may be submitted in English or metric units.

The attached flowchart shows the proper work flow for the Level 1 calculations. When a new Level 1 analysis is done, a copy of all pertinent documentation should be kept in the responsible Region office.

Each NYSDOT Region (or Program Support Center responsible for Regional load rating engineering services) shall provide new Level 1 summaries to the NYSDOT Load Rating Unit after completion. For each bridge, Level 1 data should be summarized in terms of structure rating units. A structure rating unit is defined as a single simple span or a continuous series of spans that are analyzed as a single structural unit. Thus, a bridge with three simple spans will have three rating units, but a bridge with four continuous spans will have only one rating unit.

Level 1 load rating documentation shall be incorporated into a comprehensive package to facilitate updating of the information and calculations in the future, as well as documenting the

assumptions that were used. For new, replacement, or rehabilitation projects, the Level 1 load rating package shall be transmitted as part of the Plans Specifications and Estimate (PS&E).

The following information shall be included in the Level 1 Load Rating package. Additional information may be required as part of the scope of services.

- Cover sheet with BIN; feature carried/feature crossed; political unit and county; rating summary table; analysis method and controlling member; engineers responsible for Level 1 load rating calculations (done by, checked by), approving PE signature, license number, and date.
- Table of contents.
- Level 1 Load Rating Summary Sheets for each unique member type to include 'HS' inventory and operating ratings. 'H' ratings shall also be included if the 'HS' inventory rating is less than 36 tons.
- General Information Sheet:

  1) Bridge Identification Number (BIN):
  2) Date load rating performed:
  3) Political Unit:
  4) Feature carried:
  5) Feature crossed:
  6) Superstructure type:
  7) Number of spans:
  8) Skew:
  9) Total length:
  10) Out-to-out width:
  11) Bridge width curb-to-curb:
  12) Number of actual travel lanes:
  13) Number of lanes used in rating:
  14) Type of deck:
  15) Type of wearing surface:
  16) Type of sidewalks:
  17) Barrier or railing type:
  18) Year built:
  19) Rehabilitation year(s):
  20) Design live load:
  21) Existing posted load:
  22) List of plans or sketches referenced should be provided for an existing structure:
  23) Date of most recent inspection should be provided for an existing structure:

- Drawings or sketches of Superstructure Framing Plan, Typical Cross Section and Girder Elevation. For new or rehabilitation designs, also include Moment and Shear Tables and Design Load Table.
- General description and comments affecting the Load Rating, such as structure condition, flags, posting history, etc.
- Assumptions and analysis methods

  - Live load distribution method used (AASHTO Standard Bridge Specifications, lever rule, AASHTO Guide Specification, 3D analysis, etc.)
  - Dead load distribution (tributary area, simple beam distribution, continuous transverse beam distribution, 3D analysis, etc.)
  - Analysis method (ASD, LFD and/or, LRFD), assumptions and design criteria
- Analysis
  - Section properties: As-built and deteriorated section properties as applicable; composite section properties.
  - Material properties and any assumptions.
  - Copy of any hand calculations.
  - Dead load effects, with distribution method stated. This may be taken from computer output, assuming it is easy to follow.
    - All hand calculations for all dead loads or those needed for dead load inputs shall be included.
    - Dead load assumptions, such as the weight of barriers/railings, utility lines, etc., shall be included.
  - Live loads effects, with distribution method stated and impact factor calculation.
    - All required hand calculations shall be included.
    - If alternative distribution factors are used, an explanation of why an alternative method was used and all necessary calculations shall be included.
  - Member capacities for controlling section and limit state.
  - A listing of what software was utilized including version number.
  - Copy of software input where applicable.
  - At a minimum, a printout of the summarized output.
  - Safe load and load posting calculations if applicable.
- Rating Results: Tabulated by structural rating unit with controlling member for controlling unit with controlling limit state.

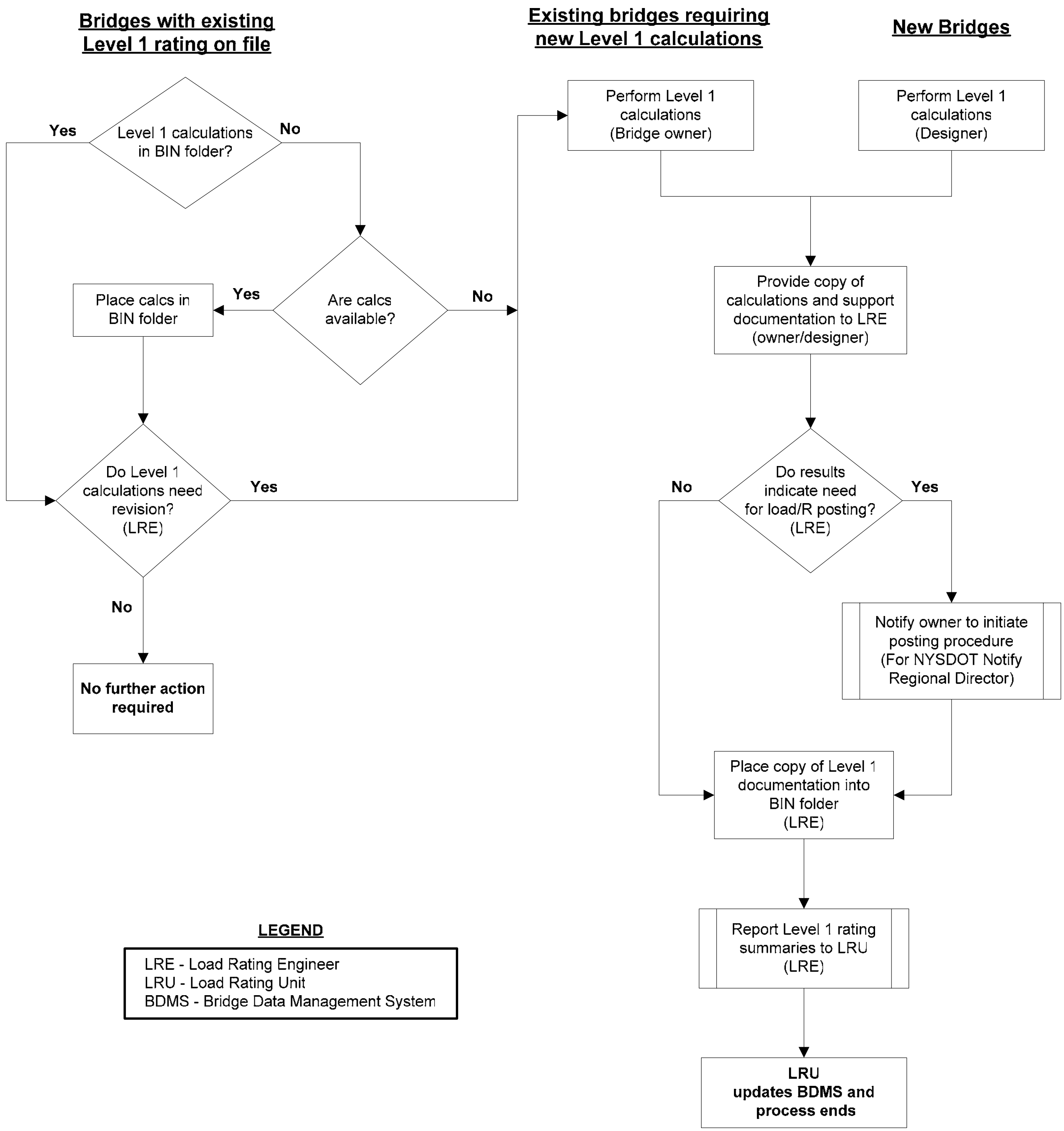
Notes:

All input sheets and calculation sheets shall show both the rater and checker.

All inspection reports, manuals, textbooks, and articles referenced as part of the load rating package shall be documented.

Typically, the substructure is not analyzed as part of a load rating; however there are cases where the substructure shall be analyzed, such as steel cap beams and steel columns. In these cases, those calculations shall be included in the load rating of the structure. At the LRE's discretion, other substructure elements not normally included in a Level 1 may need to be analyzed on an existing structure. This may be necessary in cases of extreme concrete deterioration or other mitigating circumstances.

RECORDING AND TRANSFERRING LEVEL 1 LOAD RATING DATA



Note: As previously stated, All Level 1 calculations must be certified as accurate by a professional engineer currently licensed in New York State.

3) LEVEL 2 LOAD RATING GUIDELINES

3.1) INTRODUCTION:

Level 2 load ratings are computer generated analyses of bridges produced by NYSDOT using its current bridge load rating computer systems - AASHTO Virtis and the New York Bridge Load Rating System (NYBLRS). The Load Rating Engineer is responsible for collection and Quality Control of Level 2 data for their assigned bridge inventory. The Load Rating Unit is responsible for Quality Assurance of all load rating work and management of the statewide load rating database. Input data for Level 2 ratings is generally collected as part of the NYSDOT bridge inspection program. Level 2 load rating work that is performed by consultants as part of their general bridge inspection agreements for the NYSDOT shall conform to NYSDOT specifications and standards before it is submitted to NYSDOT.

3.2) ANALYSIS FREQUENCY:

All bridges ratable by the current NYSDOT Level 2 Load Rating System shall be entered for analysis. As part of each Biennial bridge inspection, Level 2 load rating information shall be updated and the load ratings subsequently regenerated and submitted. An analysis shall be completed whether or not there has been any change to the input data. Specification changes, which are incorporated in each release of Virtis, may affect previous load rating results as well as new analysis modules that could analyze previously unratable structures. The Bridge Data Management System (BDMS) will also record an analysis date in the inventory database for processed ratings. By updating the analysis there will be a time stamp verification that the load rating for a particular structure was evaluated as part of its biennial inspection and is still valid.

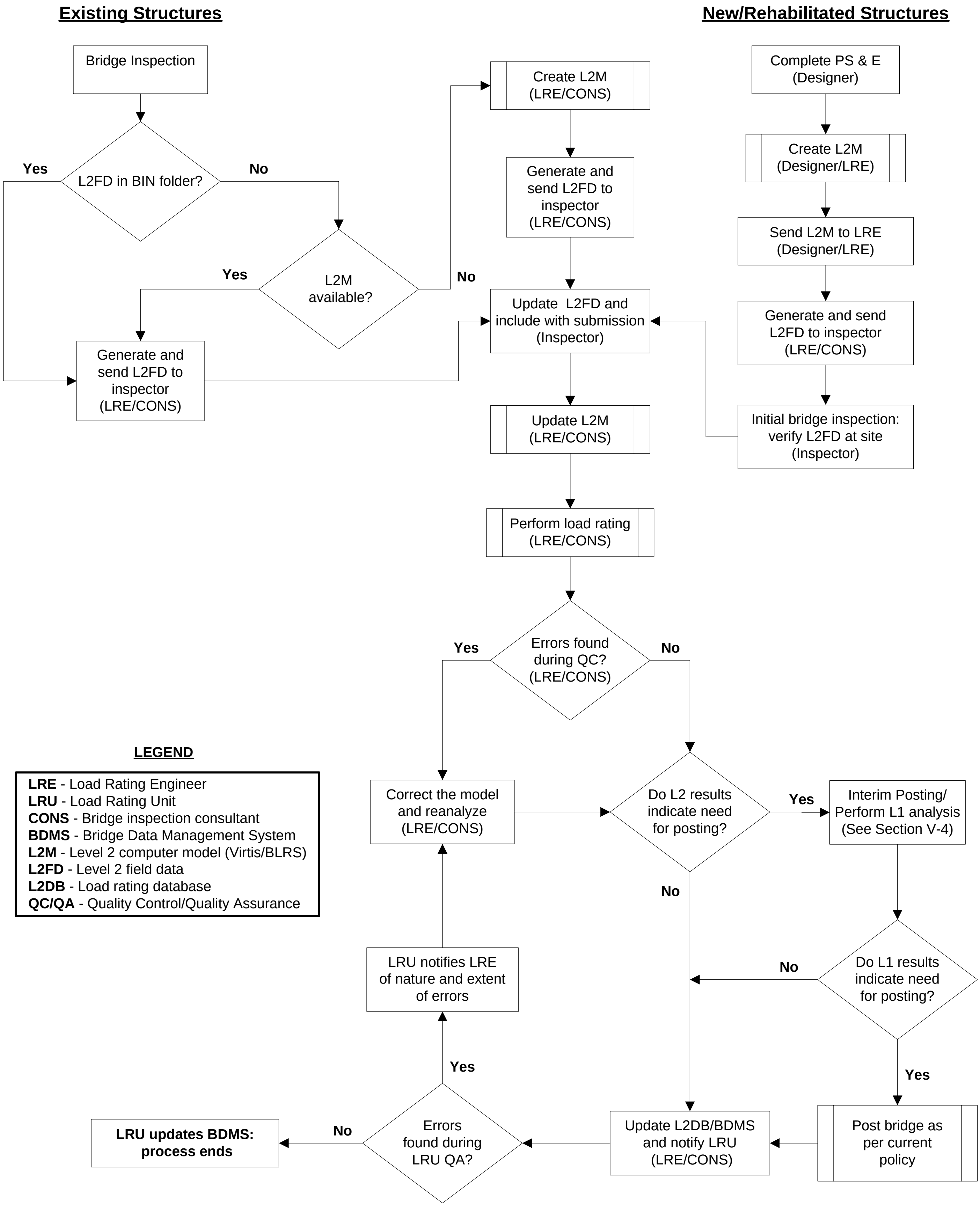
Consultants performing a Level 2 load rating analysis shall submit their results to the respective LRE. The LRE shall be responsible for transferring this data into BDMS. The Load Rating Unit is responsible for all Level 2 Quality Assurance activities. This includes final approval of submitted Level 2 load ratings in BDMS.

3.3) ANALYSIS AND SUBMISSION PROCEDURE:

The flowchart at the end of this section outlines the updating, recording, and transferring of Level 2 load rating data.

The inspector shall verify in the field the information in the BIN folder needed for the Level 2 load rating analysis. This is the Level 2 field data and may include existing bridge plans that are marked up by the Inspector or spreadsheet forms prepared by the LRE. The Level 2 field data required to perform a Level 2 analysis is at the discretion of the LRE and may vary. If there are changes, the LRE or designated staff or consultant will update the information in the BIN folder with the new data. The LRE or consultant will regenerate the Level 2 Load Rating analysis with the current data and report the new results.

RECORDING AND TRANSFERRING LEVEL II LOAD RATING DATA



4) LEVEL III LOAD RATING

When no Level 1 or Level 2 load rating exists, BDMS will generate a Level 3 load rating for the structure based on existing general inventory and inspection information such as design load, condition rating, existing posting values, etc. These ratings are not based on an analysis of the structure but on an estimate of the probable capacity of the bridge from the parameters mentioned.

These ratings are only to be used to report rating values to the FHWA when better information is not available. These ratings are not to be used for any type of structural evaluation or overload permit review.

5) BRIDGE LOAD POSTING GUIDELINES

5.1) INTRODUCTION:

This section provides guidance for load posting of NYSDOT-owned highway bridges. Because of the varying nature of structural systems, materials, frequency of loadings, and other factors which may affect a load posting, no rigid set of rules can be adopted that would be appropriate in every case.

The Region initiating the posting or change in posting must immediately give written notification to the Regional (or assigned Program Support Center) Structural Engineering Unit Manager, who will update the inventory database to reflect the change. Copies of all documentation related to posting decisions, including calculations, inspection reports, load test reports, etc., will be kept in the state BIN folder or other permanent bridge file location.

5.2) GENERAL:

The bridge owner is responsible for the decision to post a bridge and setting posting values. However, the following minimum standards must always be followed, according to Section 233 and 234 of the Highway Law, and the UCBI:

- Bridges shall not be posted at a value that will cause the operating rating level to be exceeded. As stated in the AASHTO Manual; *"Load ratings based on the operating rating level generally describe the maximum permissible live load to which the structure may be subjected."*
- The **minimum** load posting value is three tons. If the bridge cannot safely carry that load, it must be closed.
- Load posting signs shall conform to the standards for regulatory signs under the current NYSDOT (17NYCRR), Chapter V, a.k.a Manual of Uniform Traffic Control Devices (MUTCD).

5.3) CONDITION EVALUATION:

Bridges being investigated for posting must be inspected for condition as per the requirements of the UCBI, the latest edition of the NYSDOT Bridge Inspection Manual and the AASHTO Manual. The inspector must verify the accuracy of existing plans or sketches in lieu of plans with field measurements. It is especially important to measure and document items that may affect the load capacity, such as overlay thickness and section deterioration.

5.4) STRENGTH EVALUATION:

All permanent posting decisions should be based on the results of a current Level 1 load rating and field investigation. However, *"Level 2 ratings may be used to assign interim load restrictions to a deficient bridge until a Level 1 load rating can be undertaken."* – UCBI 165.8 (a) (2). Level 2 ratings shall not to be used as the basis for a permanent posting decision. The applied live loads for load rating are the standard AASHTO H and HS vehicles. Both inventory and operating ratings must be calculated. For bridges being evaluated for load posting using the guidance provided herein, the H inventory and operating ratings are used in the determination of the Safe Load Capacity (SLC).

There are many bridges for which common analytical methods are not adequate to determine a load rating. The following are some examples:

- Bridges that cannot be realistically modeled using routine analytical methods.
- Bridges with unavailable or incomplete plans and structural components that cannot be measured. Examples include (but are not limited to) steel beams encased in concrete and concrete structures with unknown reinforcement or prestressing.
- Timber bridges with unknown material properties.

For cases like these, alternate methods of load rating may need to be used to generate realistic load rating results.

5.5) DETERMINATION OF SAFE LOAD CAPACITY (SLC) AND POSTING VALUES:

The SLC is a load rating value that corresponds to an acceptable stress level from actual traffic loads. **Load posting is required if the SLC for a given span is less than the H equivalent rating of a legal load.** A maximum legal load effect will be equivalent to different H rating values depending on the effective span length, as shown in Table 1. The effective span is the length of the live load influence line for the member action (moment or shear) that the member's rating is based on.

The SLC limits set forth in these guidelines are not intended to be entirely rigid. The evaluating engineer may exceed these limits based on engineering judgment or factors unique to the bridge, provided that the rationale for doing so is documented in the posting analysis. In no case, however, shall the SLC exceed the Operating Rating. Conversely, individual situations may warrant using lower SLC values than those presented in these guidelines.

TABLE 1

"H" - LOADING EQUIVALENT TO LEGAL LOADS

Effective Span Length - ft	H Equivalent of Legal Load
Up to 12*	H16
13 - 19*	H18
20 - 34	H22
35 - 45	H23
46 - 53	H24
54 - 75	H25
76 - 90	H24
91 - 105	H23
106 - 120	H22
121 - 140	H21
Over 140	H20

* Generally applies to stringers and floorbeams only

Note: R posting may be necessary for bridges where the SLC is above the threshold level required for load posting. See Section VI.

As an example, if the H SLC is 23 tons, and the maximum effective span is 32 feet, posting is not required. However, if the effective span is 64 feet, posting is required.

Member Type	Effective Span
1) Simple span stringers or girders	Span length
2) Continuous stringers or girders	
a) Positive moment and shear	Span length
b) Negative moment	Average of adjacent span lengths
3) Floorbeams	
a) End floorbeam	Adjacent stringer span or panel length
b) Intermediate floorbeam	Sum of two adjacent stringer spans or panel lengths
4) Trusses	
a) Chords and end posts	Total span length
b) Interior diagonals	Panel length + sum of panel lengths to far support
c) Vertical hangers or posts	Same as intermediate floorbeam
d) Vertical part of truss web	Same as interior diagonals

TABLE 2
SAFE LOAD CAPACITY DETERMINATION GUIDELINES

<table>
<tr><th>Bridge Type & Characteristics</th><th>Primary Member Rating</th><th>SLC</th></tr>
<tr><td rowspan="2">1. Steel primary members that are both internally and load path nonredundant:
• Two and three member welded plate girder bridges or rolled beams that have partial-length welded cover plates or other fatigue category D, E, or E’ details.
• Truss members with pinned eye bars or threaded rods.
• Welded truss members and truss members with welded connections.
• Floorbeams spaced at more than 12' that have timber or steel grating decks.
• Pin and hanger connections.
• Floorbeam hanger connections.

2. All primary members with extensive section loss that significantly affects the load rating of the structure.</td><td>≤3</td><td>0.60 HOR*</td></tr>
<tr><td>≥4</td><td>0.70 HOR</td></tr>
<tr><td rowspan="2">3. All load path redundant steel members including welded girders, riveted girders, and rolled stringers.
4. Rolled or welded truss members with riveted or bolted connections.
5. Rolled two girder bridges without fatigue category D, E, or E’ welds.

6. All internally redundant members (excluding floorbeams described in #1) regardless of load path redundancy including: Riveted truss members; Riveted through or deck main girders.

7. Floor system members;
• All floor system stringers.
• All steel floorbeams with concrete decks regardless of spacing.
• All steel floorbeams spaced 12’ or less regardless of deck type.

8. All concrete beam or slab members.</td><td>≤3</td><td>0.80 HOR</td></tr>
<tr><td>≥4</td><td>0.85 HOR</td></tr>
<tr><td>9. Load path redundant members and floor system members where it can be demonstrated that there is capacity above that computed by the normal load rating assumptions. This added capacity may be demonstrated by a greater roadway width than is required by the actual number of traffic lanes and also, excess redundant members.

10. Box or H shaped compression chords of trusses with adequate lateral support and no signs of lateral movement.</td><td colspan="2">Up to HOR</td></tr>
</table>

* HOR-H Operating Rating

Note: Connections for the above primary member types, excluding splices, shall be evaluated with the same criteria as the primary member.

The SLC recommendations in Table 2 are a function of the calculated operating rating of the controlling member, whether determined using Allowable Stress or Load Factor analysis methods. Operating rating results for both methods will generally be comparable for the same bridge. However, inventory ratings for both methods can differ greatly. The inventory rating for the Load Factor method is directly proportional to the operating rating (HIN=0.6HOP). Whereas, the inventory rating for Working Stress can fluctuate independent of the operating rating for different bridge types and for bridges with different dead load to live load ratios. Basing the SLC calculations on the inventory rating could significantly penalize a bridge with a low inventory but, high operating rating.

The SLC may be allowed up to the operating rating for load path redundant members in good condition and floor systems where it can be demonstrated that there is capacity above that computed by the Load Rating Specification assumptions. This added capacity is normally attributed to excess roadway widths in comparison to the actual number of travel lanes and/or sufficient redundant members. A posting decision for these members can be based on the operating rating if it can be shown that there is at least 125% of equivalent legal load capacity available due to excess roadway width or redundancy.

Decimal values resulting from these guidelines should be truncated to the nearest ton. For instance, a calculated result of 12.71 tons should be truncated to 12 tons.

The SLC may be used directly as the posting value. However, this may be over-conservative for some span lengths, since the H-type vehicle is not a legal weight and spacing configuration for two-axle trucks. To account for the different configurations of legal loads, Table 3 may be used to convert the SLC (which is based on the H vehicle) into a posting value.

TABLE 3

MAXIMUM POSTING VALUES (TONS)

"Safe Load Capacity" (Based on H type truck)

Eff. Span (ft)	3-9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Up to 12		12	15	16	18	20	22									
13 - 19		10	12	14	15	16	18	20	22							
20 - 34		10	12	12	14	15	16	16	18	18	20	22	22			
35 - 45	Use	10	11	12	13	14	15	16	18	18	20	20	22	22		
46 - 53	SLC	10	11	12	13	14	15	16	17	18	19	20	22	22	24	
54 - 64	Value	10	11	12	13	14	15	16	17	18	19	20	22	22	24	25
65 - 75	directly	10	12	12	14	15	16	16	18	20	20	22	22	24	25	25
76 - 90		10	12	14	15	16	18	18	20	20	22	24	25	25	25	
91 - 105		10	12	15	16	16	18	20	22	22	24	25	25	28		
106 - 120		12	14	15	18	18	20	22	22	25	25	28	28			
121 - 140		12	16	18	20	20	22	25	25	28	28	30				
Over 140		12	16	18	20	20	22	25	25	28	30					

5.6) EXAMPLES:

1) A truss bridge with primary member condition rating of 3, based on pitting of the lower chords and floorbeams. All components are rolled sections or riveted built-up sections, except the bottom chord, which is composed of pinned eye bars. There are seven stringers in the floor system cross section. The bridge has an open steel grating deck. Main span is 141 ft, floorbeam spacing is 14 ft, and overall width is 28 ft. Effective Span, H equivalent of legal load and H operating ratings (Allowable Stress) are as follows:

Component	Effective Span (feet)	H equiv of legal load	H Operating (HOR)
stringer (rolled)	14	H18	H25
floorbeam (built-up)	28	H22	H21
bottom chord (eye bar)	141	H20	H23
top chord (built-up)	141	H20	H26
diagonal (built-up)	70	H25	H24

To find out the posting value for this truss, it is necessary to determine the SLC for all components. Each one will have a different SLC based on member type and rating.

The stringers in this floor system are load path redundant and the cross section consists of excess redundant members. Based on this, the stringer can be shown to fall under category 9 in Table 2. The SLC in this grouping can be up to the HOR = H25. In this case it is acceptable to use the full operating rating for the SLC because the low primary member ratings are not based on the stringers, which are in good condition. If they were not in good condition, the engineer would have to use their discretion as to how close to the operating rating the SLC should be. Using Table 1, the H equivalent of legal load for an effective stringer span of 14 ft is H18. This is less than the SLC of H25 therefore; the bridge does not need to be posted based on the stringer rating.

The H equivalent for a legal load over the floorbeam effective span of 28 ft is H22 (Table 1). This is greater than the floorbeam operating rating of H21. Therefore, it is necessary to determine the SLC of the floorbeam. The floorbeam (w/steel deck) falls under category 1 in Table 2. The SLC is 0.60HOR = H12.6 ≈ H12.

For the diagonal, the operating rating (H24) is also less than the H equivalent of a legal load (H25) for the effective span. The diagonal is internally redundant, but not load path redundant and, has riveted connections at its ends. This places it in category 6 in Table 2. With a primary member rating of 3 the SLC is 0.80HOR = H19.

The eye bar operating rating (H23) is greater than the H equivalent of a legal load for the effective span length (H20). However, eye bars are vulnerable to stress corrosion and brittle fracture, since eye bars were often fabricated from steels with poor notch toughness. Also, eye bar connection details attract moisture, making further section loss likely. Using the guidelines

in Table 2, category 1, results in an SLC value of 0.60HOR = H13.

The top chord falls into category 6 in Table 2. The SLC is 0.85HOR = H22, which is greater than the H equivalent (H20) of a legal load. Therefore, it will not govern.

Component	Effective Span (feet)	H equiv of legal load	SLC
stringer (rolled)	14	H18	H25
floorbeam (built-up)	28	H22	H12
bottom chord (eye bar)	141	H20	H13
top chord (built-up)	141	H20	H22
diagonal (built-up)	70	H25	H19

To set the posting value, it is acceptable to directly use the floorbeam SLC value of 12 tons. This may be conservative and, some evaluating engineers may want to check this posting value against the posting that Table 3 would yield. If Table 3 is used, the floorbeam, diagonal, and the bottom chord must be evaluated. For the floorbeam, an SLC of H12 over an effective span of 28 ft in Table 3, yields a posting value of 12 tons. For the diagonal SLC of H19 over an effective span of 70 ft, the Table 3 value is 20 tons. In Table 3, the posting value for the bottom chord SLC of H13 over an effective span of 141 ft is 20 tons. The floorbeam still governs for posting. Using Table 3 yields a posting value of 12 tons based on an SLC of H12 for the floorbeam. However, as shown with the diagonal and bottom chord, Table 3 may yield a higher posting value in some cases.

2) Single-span rolled beam bridge with five stringers originally designed for an H15 load. The primary member rating is 3 based on section loss on the fascia stringers. There is also deterioration on the interior stringers that is not as extensive. Main span equals 61 ft, with Level 1 H inventory and operating ratings of 14 and 24 tons, respectively.

Posting for this bridge will be required, since the operating rating is lower than the H equivalent for the legal load applied to a span of 61 ft of H25 (Table 1). The bridge was not designed for current legal loads, there is significant deterioration and, with only five members in the cross section there is no excess redundant capacity. Using the SLC guideline for category 2 from Table 2, we can say that this bridge has an SLC value equal to 0.60HOR = H14.

As per Table 3, a SLC of H14 over a span of 61 ft yields a posting value of 14 tons.

6) CRITERIA FOR POSTING BRIDGES FOR R - PERMIT RESTRICTIONS

6.1) INTRODUCTION

R-Postings are intended to keep most overloads from using bridges that, through design or deterioration, do not have the reserve capacity to accommodate most overload permit vehicles, but are still capable of safely carrying legal loads. These bridges have signage stating “No Trucks with R Permits.” If any of the following apply, the bridge should be investigated to determine the need for posting for R restriction.

Criteria used to determine R-Posting:

- Low operating rating.
  - Below H29 Upstate
  - Below H33 Downstate *
- Design load below H20, with no level 1 or level 2 load rating available.
- Bridge width (curb-to-curb).
  - Below 24 feet Upstate
  - Below 28 feet Downstate *
- Primary member condition rating below 4.
- Structural deck condition rating of 1.
- Regional prerogative.

∗ Downstate includes the following:
Region 8
Dutchess, Putnam, Orange, Rockland and Westchester Counties
Region 10
Nassau and Suffolk Counties

Note: NYSDOT does not currently have permitting responsibilities in New York City, and is therefore not included as part of the R-Posting process.

The H29 and H33 thresholds were developed using multipresence reduction factors. This was based on the unlikelihood of two overload permit vehicles being situated at the most critical location of a bridge simultaneously. Bridges whose controlling ratings are governed by fascia girders not designed to current specifications, single-lane bridges, certain connections, and other controlling elements where multi-presence reduction is not applicable may need to be evaluated at a higher threshold. A Region may exercise their prerogative in cases such as these or others where a higher threshold for R-Posting can be justified.

The bridge width criterion was initially included when load ratings were not as widely available as they are now. It was intended to ensure that bridges that allow overloads were designed for two travel lanes. A bridge designed for two lanes provides some overload reserve capacity not available in a single lane structure. If a level 1 or level 2 load rating exists, the rating should be used to determine overload capacity for the structure and the width criterion may not be considered.

Regional prerogative may be used where circumstances warrant restricting overload vehicles

from crossing a structure for reasons other than those listed above.

6.2) REEVALUATION OF POSTING STATUS

The presence of load or R posted bridges can be quite disruptive to users of the highway system. Whenever any remedial work is done on a posted bridge (including dead load reduction), an evaluation should be done as soon as possible to determine if it is still necessary to be R-Posted. If a bridge is posted based on a level 1 load rating, and a new Level 2 indicates a capacity above the R-Posting threshold, the level 1 calculations should be reviewed to insure the level 1 load rating and prior posting are still valid.

Conversely, reevaluation is also needed to ensure that any existing posting values are still adequately protecting the bridge. Every inspection report and updated level 2 rating should be examined closely to ensure that the initial posting determination is still applicable.

7) FIELD LOAD TESTING

7.1) INTRODUCTION

Field load testing, also referred to as nondestructive load testing, is an experimental determination of a structure’s load capacity by measuring the actual structural response to known loads. The measured response of the bridge under the field load test is then compared to the analytical predicted response. Load testing can be a useful part of a load rating calculation for a bridge that is difficult to load rate using conventional analytical methods. Load testing may also provide a more accurate and at times higher rating, which can be very helpful when the theoretical safe live load capacity is lower than desirable. Load testing is typically separated into two types; diagnostic and proof testing.

Diagnostic load testing involves measuring the load effects (such as moment, shear, axial force, stresses, and deflection caused by known loads, such as a specific vehicle or vehicles of known weight, axle loads, and spacings). The results of the load tests are then compared to those predicted using analytical calculations. The difference between the theoretical and measured load effects will then be reviewed and calibrated to the standard AASHTO HS and/or H rating vehicles. The results will then be used to establish the new load rating. Load testing typically involves measurements of load effects of several bridge members at critical locations.

Proof load testing involves loading the bridge with incremental loads until a targeted load level is safely reached. This level is then used to set the level of the new load rating. Loading should be done incrementally while the bridge is carefully monitored. The loading should be discontinued at any sign of distress or damage. Proof load testing requires careful preparation and experienced personnel. Care is required to avoid damage to the structure as well as to prevent injuries to personnel and to the public.

If done incorrectly, field load testing can lead to inaccurate load rating results. In addition, incorrect testing procedures can lead to permanent damage and even possible collapse of the bridge structure. Sound engineering judgment and analytical principles need to be taken into consideration before load testing is performed. See the AASHTO Manual and, the references

listed in 7.3 below for more additional information on conducting field load tests.

7.2) DOCUMENTATION OF RESULTS

Every test report must include certain information, regardless of test procedure. At a minimum, provide the following:

- Truck weights, axle spacing, and axle loadings.
- Exact location of truck(s) on the bridge for all strain or deflection measurements.
- Types of measuring instruments used (strain gauges, survey rods, etc.)
- Location of measuring instruments.
- Conversion calculations to HS equivalents (as well as H if applicable).
- Reasons for increased capacity above the analytical predicted load rating.

The report shall be signed by the responsible professional engineer licensed by the State of New York, and filed with NYSDOT using the same procedures as for an in-depth Level 1 load rating. All load test documentation and results should be kept in the Region (or responsible Program Support Center) office. If used to generate a Level 1 load rating, the actual results of the load test are only a portion of the Level 1 documentation. In addition to the load testing documentation, the procedures in the preceding Level 1 guidelines shall be followed.

7.3) REFERENCES

- NYSDOT Research Report 163 "Highway Bridge Rating by Nondestructive Proof-Load Testing for Consistent Safety." NYSDOT Transportation Research and Development Bureau.
- NYSDOT Research Report 153 "Proof Testing of Highway Bridges" NYSDOT Transportation Research and Development Bureau.
- “Manual for Bridge Rating Through Load Testing.” Research Results Digest, No. 234, Transportation Research Board, National Research Council, Washington, D.C., (1998).
- Barker, Michael G. “Quantifying Field-Test Behavior for Rating Steel Girder Bridges.” Journal of Bridge Engineering, July/August 2001, pp. 254-261.

CONTACT: For questions concerning this Engineering Instruction contact the Load Rating Unit at (518) 457-5498.