

U.S. Department of Transportation
Federal Highway Administration

2018 Rating and Design Bridge User Group (RADBUG) Meeting
August 7 – 8, 2018
Boise, ID

Load Rating for SHVs and EVs and Other Challenges

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Outline

- Introduction
- Specialized Hauling Vehicles (SHVs)
- Emergency Vehicles (EVs)
- Other Challenges
- Q and A

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Introduction

- Describe how SHVs and EVs impact bridge operations
- Explain how to post for vehicles that will exceed bridge capacities from load ratings
- Describe FHWA policies for bridge load rating for SHVs and EVs
- Examine State's approaches for compliance with FHWA policies
- Discuss challenges

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AASHTO SHVs

- Adopted by AASHTO in 2005 to represent new truck models: SU4, SU5, SU6, SU7 and NRL
- Meet all Federal weight limitations:
 - 23 CFR 658.17
 - 23 U.S.C. § 127
- High axle loads over shorter distances
- Moveable axles – raise/lower as needed for weight - Variable Load Suspension (VLS) Axles

http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_575.pdf

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Federal Weight Limits

- Single Axle Limit – 20,000 pounds
- Tandem Axle Limit – 34,000 pounds
- Gross Vehicle Limit – 80,000 pounds
- Bridge Formula B

$$W = 500 \left\{ \frac{LN}{N-1} + 12N + 36 \right\}$$

Where N = # of axles
L = distance between first and last axle (ft)
W = weight (lbs)

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AASHTO SHVs – Example Load Effects

Force Effect	Max Overstress Ratio
Simple Span Bending	1.49
Simple Span Shear	1.37
Two-Span Continuous Positive Bending	1.48
Two-Span Continuous Negative Bending	1.26
Two-Span Continuous Shear	1.36
Three-Span Continuous Positive Bending	1.48
Three-Span Continuous Negative Bending	1.39
Three-Span Continuous Shear	1.35
Four-Span Continuous Positive Bending	1.48
Four-Span Continuous Negative Bending	1.34
Four-Span Continuous Shear	1.34

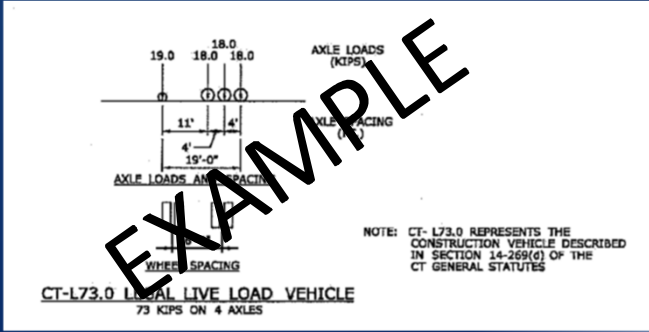
FHWA-NHI-130092 - Fundamentals of LRFR and Applications of LRFR for Bridge Superstructures

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State-Specific SHVs

- SHVs exceeding Federal weight limits
 - CT Legal Specialized Hauling Vehicle
 - <http://www.ct.gov/dot/cwp/view.asp?a=4048&Q=562040&PM=1>



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Specialized Hauling Vehicles

- Rate/post bridges for the SHVs

Per AASHTO Manual for Bridge Evaluation:

- 6A.4.4.2.1b—Specialized Hauling Vehicles
- 6B.7.2—Posting Loads
 - The live load to be used in the rating Eq. 6B.4.1-1 for posting considerations should be any of the three typical legal loads shown in Figure 6B7.2-1, *any of the four single unit legal loads shown in Figure 6B7.2-2 or state legal loads.*

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Specialized Hauling Vehicles

- **AASHTO SHVs**
 - Rate bridges for the AASHTO SHVs
 - SU4, SU5, SU6, SU7 and NRL
 - Post bridges (if necessary) for the AASHTO SHVs
 - SU4, SU5, SU6, SU7
- **State-Specific SHVs**
 - Rate and post (if necessary) bridges for the State-specific SHVs using the specific rating vehicle models.

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Posting Signs

MBE Articles 6A.8.2: When the maximum legal load under State law exceeds the safe load capacity of a bridge, restrictive load posting shall be required. Though there is variation among the States with respect to the type of signs preferred for posting bridges, most states use either a single weight-limit sign or a three-vehicle combination sign. In any case, the posting signs shall conform to the Manual on Uniform Traffic Control Devices (MUTCD).

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Posting Signs

Possible Posting Signs

BRIDGE WEIGHT LIMIT - TONS	
SINGLE VEHICLE	16
COMBINATION VEHICLE	20

R12-I100

BRIDGE WEIGHT LIMIT - TONS	
SINGLE VEHICLE	17
COMBINATION	21
3 OR 4 AXLES	21
5 OR MORE	23

R12-I100

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Posting Signs

Possible Posting Signs

BRIDGE WEIGHT LIMIT - TONS	
SINGLE VEHICLE	
COMBINATION	
3 OR 4 AXLES	21
5 OR MORE	23

3 OR LESS AXLES	12
4 OR 5 AXLES	16
6 OR MORE AXLES	20


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Specialized Hauling Vehicles

- FHWA Guidance:

 **Memorandum**

U.S. Department of Transportation
Federal Highway Administration

Subject: **ACTION:** Load Rating of Specialized Hauling Vehicles Date: November 15, 2013

From: *As Original Signed by*
Joseph S. Krolak, Acting Director, Office of Bridge Technology In Reply Refer To: HIBT-10

To: Federal Lands Highway Division Engineers
Division Administrators

The purpose of this memorandum is to clarify FHWA's position on the analysis of *Specialized Hauling Vehicles (SHVs)* as defined in the AASHTO Manual for Bridge Evaluation (MBE) during bridge load rating and posting to comply with the requirements of the *National Bridge Inspection Standards (NBIS)*. The intent of the load rating and posting provisions of the NBIS is to insure that all bridges are appropriately evaluated to determine their safe live load carrying capacity considering all unrestricted legal loads, including State routine permits, and that bridges are appropriately posted if required, in accordance with the MBE.

<https://www.fhwa.dot.gov/bridge/loadrating/161103.cfm>

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Specialized Hauling Vehicles

- Load rate and post for SHVs to meet timelines – 2017, 2022
 - Completion dates for Groups 1 and 2 are December 31, 2017 and December 31, 2022, respectively.
 - If a re-rating is warranted ahead of the group completion date, due to changes of structural condition, loadings, configuration, or for other reasons, the re-rating should include the AASHTO SHVs.

[23 CFR 650.313(c)]

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Specialized Hauling Vehicles

- Determine if SHVs are legal in your State
- Parametric study
 - Determine if State has a load rating or posting vehicle that encompasses the AASHTO SHVs
 - Establish State-specific SHVs to be used in bridge rating and posting in compliance with NBIS
- Alternative method to prioritize SHVs' load rating per November 15, 2013, Memorandum

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FAST Emergency Vehicles

- Pursuant to Section 1410 of the FAST Act, Emergency Vehicles (EVs) are designed to be used under emergency conditions to transport personnel and equipment to suppress fires and mitigate other hazardous situations (23 U.S.C. 127(r)(2)). Under this provision, the gross vehicle weight (GVW) limit for EVs is 86,000 pounds. The statute authorizes the following additional weight limits, depending upon vehicle configuration:
 - 24,000 pounds on a single steering axle;
 - 33,500 pounds on a single drive axle;
 - 62,000 pounds on a tandem axle; or
 - 52,000 pounds on a tandem rear drive steer axle.

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FAST Act Emergency Vehicles

- Impact of the FAST Act Emergency Vehicles
 - They create higher stresses in bridge structures than normal operational legal loads i.e., AASHTO Type 3, 3S2 and 3-3, and SHVs.
 - FAST Act EVs are legal in all States on Interstates and within Reasonable Access to Interstates.

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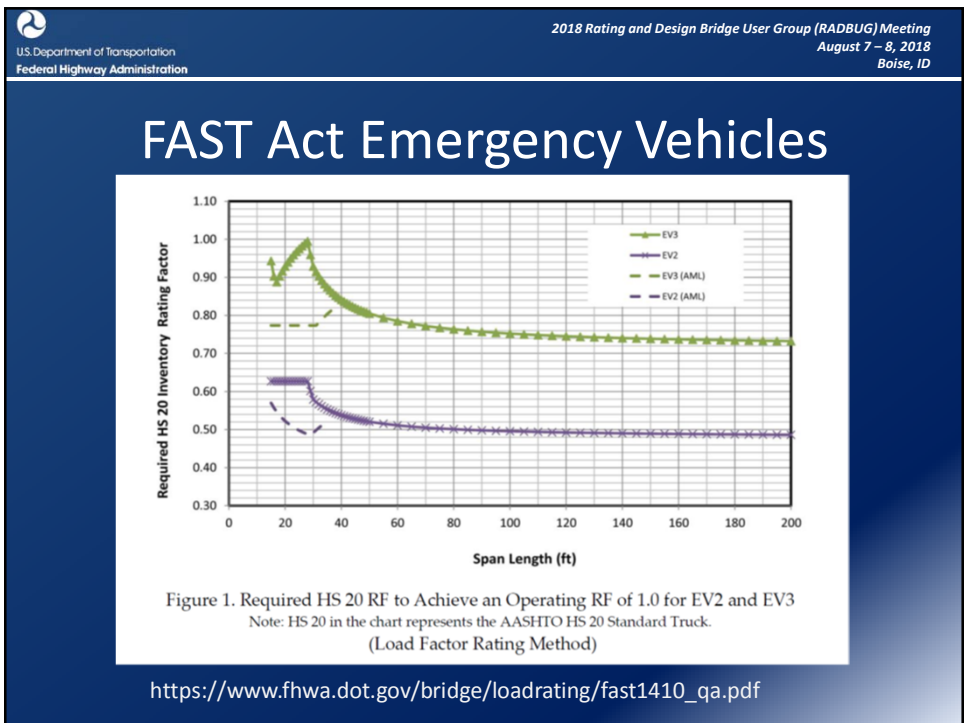
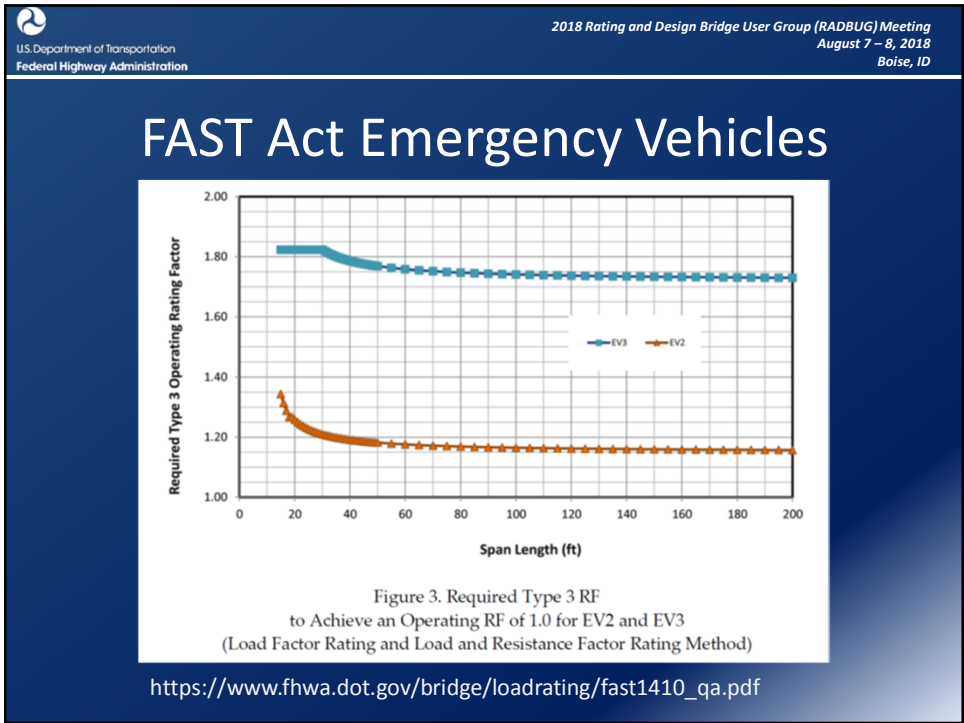
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FAST Act Emergency Vehicles

- Impact of the FAST Act Emergency Vehicles
 - GVW: $\frac{86,000}{80,000} = 107.5\%$; Type 3: $\frac{86,000}{50,000} = 172\%$
 - Single: $\frac{33,500}{20,000} = 167.5\%$
 - Tandem: $\frac{62,000}{34,000} = 182.4\%$

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FAST Act Emergency Vehicles

- Rate/post bridges for FAST Act EVs
 - Live load configuration
 - Live load factor
 - Live load multiple presence
 - Dynamic allowance
 - Live distribution factor
 - Tire contact area

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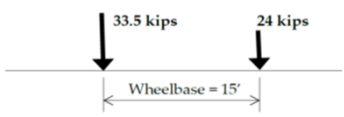
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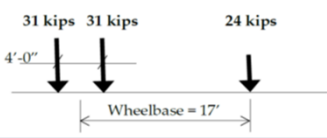
FAST Act Emergency Vehicles

- Live load configurations (load models):

Type EV2:
Front Single Axle: 24,000 pounds
Rear Single Axle: 33,500 pounds
Wheelbase: 15 ft.



Type EV3:
Front Single Axle: 24,000 pounds
Rear Tandem Axle: 62,000 pounds (two 31,000 pound axles spaced at 4 ft.)
Wheelbase: 17 ft. (distance from front axle to the centerline of rear tandem axle)



https://www.fhwa.dot.gov/bridge/loadrating/fast1410_qa.pdf

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FAST Act Emergency Vehicles

- Live load factor:
 - LFR: 1.3
 - LRFR: 1.3
 - Not calibrated due to lack of data for the EVs. The value of 1.3 was chosen based on the assumption of similar weight spectra as compared to other legal loads to maintain a similar safety margin.

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FAST Act Emergency Vehicles

- Dynamic Allowance
 - Same as for AASHTO legal loads in MBE
 - Available data is insufficient to suggest a reduced impact factor or dynamic allowance
- Contact Area
 - The tire contact area specified in the AASHTO LRFD Article 3.6.1.2.5 may be used in lieu of better information
- Live Load Distribution Factor:
 - Assume standard wheel gauge width

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FAST Act Emergency Vehicles

- **Multiple Presence:**
 - If necessary, when combined with other unrestricted legal loads for rating purposes, the emergency vehicle needs only to be considered in a single lane of one direction of a bridge.
 - Question/Answer No. 21:
 - If using the simplified live load distribution equations in the AASHTO Specifications, choose the appropriate equation based on the number of design lanes (one lane or multiple lanes). However, for narrow bridges with roadway widths less than 18 ft. where one-lane distribution factor in the AASHTO LRFD Specifications is used, the LRFD built-in multiple presence factor of 1.2 may be divided out. When performing refined analysis, only one EV needs to be considered simultaneously to combine with other legal loads.

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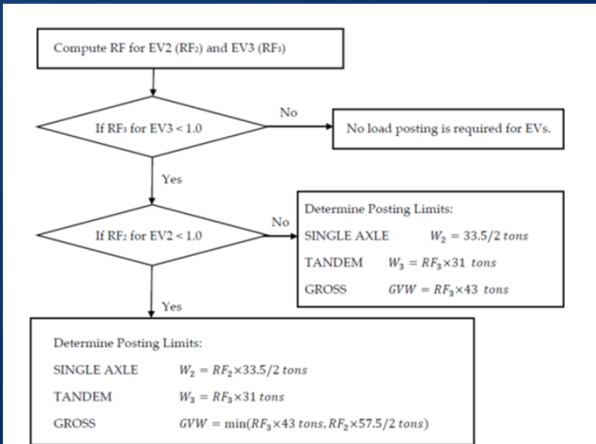


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FAST Act Emergency Vehicles

- **Safe Posting Load:**



```

    graph TD
      Start[Compute RF for EV2 (RF2) and EV3 (RF3)] --> D1{If RF3 for EV3 < 1.0}
      D1 -- No --> NoPosting[No load posting is required for EVs.]
      D1 -- Yes --> D2{If RF2 for EV2 < 1.0}
      D2 -- No --> D1a[Determine Posting Limits:  
SINGLE AXLE W2 = 33.5/2 tons  
TANDEM W3 = RF3 x 31 tons  
GROSS GVW = RF2 x 43 tons]
      D2 -- Yes --> D1b[Determine Posting Limits:  
SINGLE AXLE W2 = RF2 x 33.5/2 tons  
TANDEM W3 = RF3 x 31 tons  
GROSS GVW = min(RF3 x 43 tons, RF2 x 57.5/2 tons)]
      
```

Figure 5. Posting Value Flowchart

https://www.fhwa.dot.gov/bridge/loadrating/fast1410_qa.pdf

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Posting Signs

Posting Signs – R12-7 Series

EXAMPLES

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FAST Emergency Vehicles

- FHWA Guidance:

Memorandum

U.S. Department of Transportation
Federal Highway Administration

Subject: **ACTION:** Load Rating for the FAST Act's Emergency Vehicles Date: November 3, 2016


From: /Original signed by/ Joseph L. Hartman, Ph.D., P.E. Director, Office of Bridges and Structures In Reply Refer To: HIBS-1

To: Division Administrators
Federal Lands Highway Division Directors

On December 4, 2015, the President signed into law the *Fixing America's Surface Transportation Act* (FAST Act) (Pub. L. 114-94). Section 1410 of the FAST Act amended 23 U.S.C. 127, *Vehicle weight limitations—Interstate System*, by revising the weight limits for certain vehicles on the Interstate System. The purpose of this memorandum is to provide guidance on maintaining compliance with the load rating and posting requirements of 23 CFR Part 650—specifically for the amended weight limits in 23 U.S.C. 127(i), *Emergency Vehicles*, for bridges on the Interstate System and within

<https://www.fhwa.dot.gov/bridge/loadrating/161103.cfm>

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FAST Act Emergency Vehicles

- Load rate and post for the EVs timelines
 - Bridges in Group 2: next inspection, but no later than December 31, 2019.
 - Bridges not on the Interstate and not within reasonable access to the Interstate by December 31, 2022.
 - Whenever a normal re-rating is warranted [23 CFR 650.313(c)].

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FAST Act Emergency Vehicles

- Legal in all States on Interstates and within reasonable access to Interstates
- Determine legality on other routes
 - Adopt FAST Act EV provisions
 - Exempt EVs from truck size and weight (TS&W) law
 - Exempt EVs from obeying weight restrictions
 - Exempt the combination of the above
- Plan of action
 - Prioritize EVs load rating

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Other Challenges

- Completion of Plan of Corrective Actions (and Plan of Actions) to Meet NBIS/NTIS Requirements
- Maintenance of Load Rating to Keep Bridge Load Ratings Up to Date
 - Aging of structures
 - Increase of loads
 - Dead loads
 - Live loads
 - Change of Specifications

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Other Challenges

- Maintenance of Load Rating to Keep Bridge Load Ratings Up to Date
 - Introduction of new highway loadings
 - State statute and 23 U.S.C. 127

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Other Challenges

- Maintenance of Load Rating to Keep Bridge Load Ratings up to Date
 - Introduction of new, heavier truck loadings
 - Example: New Virginia law allows heavier trucks

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Other Challenges

- Maintenance of Load Rating to Keep Bridge Load Ratings up to Date
 - Introduction of new, heavier truck loadings
 - FAST Act Section 1410 Interstate Weight Limits (2015)
 - Covered Heavy-Duty Tow and Recovery Vehicles [23 U.S.C. 127(m)]
 - Natural Gas Vehicles [23 U.S.C. 127(s)]

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Other Challenges

- Maintenance of Load Rating to Keep Bridge Load Ratings up to Date
 - Introduction of new, heavier truck loadings
 - FAST Act Section 1410 Interstate Weight Limits (2015)
 - Operation of Vehicles on Certain Highways in the State of Texas [23 U.S.C. 127(n)]
 - Certain Logging Vehicles in the State of Wisconsin [23 U.S.C. 127(o)]
 - Operation of Certain Specialized Vehicles on Certain Highways in the State of Arkansas [23 U.S.C. 127(p)]
 - Certain Logging Vehicles in the State of Minnesota [23 U.S.C. 127(q)]

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Other Challenges

- Maintenance of Load Rating to Keep Bridge Load Ratings up to Date
 - Introduction of new, heavier truck loadings
 - Consolidated Appropriations Act, 2016
Section 127 of title 23, United States Code is amended:
“(t) VEHICLES IN IDAHO.—A vehicle limited or prohibited under this section from operating on a segment of the Interstate System in the State of Idaho may operate on such a segment if such vehicle—
 - “(1) has a gross vehicle weight of 129,000 pounds or less;
 - “(2) other than gross vehicle weight, complies with the single axle, tandem axle, and bridge formula limits set forth in subsection (a); and
 - “(3) is authorized to operate on such segment under Idaho State law.”

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Other Challenges

- Maintenance of Load Rating to Keep Bridge Load Ratings up to Date
 - Introduction of new, heavier truck loadings
 - Consolidated Appropriations Act, 2018

Section 127 of title 23, United States Code is amended:

“(u) Vehicles In North Dakota.—A vehicle limited or prohibited under this section from operating on a segment of the Interstate System in the State of North Dakota may operate on such a segment if such vehicle—

- “(1) has a gross vehicle weight of 129,000 pounds or less;
- “(2) other than gross vehicle weight, complies with the single axle, tandem axle, and bridge formula limits set forth in subsection (a); and
- “(3) is authorized to operate on such segment under North Dakota State law.”

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Other Challenges


- Maintenance of Load Rating to Keep Bridge Load Ratings up to Date
 - Introduction of new, heavier truck loadings
 - Consolidated Appropriations Act, 2018

Section 127(a)(10) of title 23, United States Code, is amended:

“(10) With respect to Interstate Routes 89, 93, and 95 in the State of New Hampshire—

- “(A) State laws (including regulations) concerning vehicle weight limitations that were in effect on January 1, 1987, and are applicable to State highways other than the Interstate System, shall be applicable in lieu of the requirements of this subsection; and
- “(B) effective June 30, 2016, a combination of truck-tractor and dump trailer equipped with 6 axles or more with a gross weight of up to 99,000 pounds shall be permitted if the distances between the extreme axles, excluding the steering axle, is 28 feet or more.”

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Other Challenges

- Maintenance of Load Rating to Keep Bridge Load Ratings up to Date
 - Introduction of new highway loadings
 - Freight demands
 - Heavier trucks
 - Truck platooning
 - Implements of husbandry
 - School buses

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Other Challenges


- Maintenance of Load Rating to Keep Bridge Load Ratings up to Date
 - Standardization of software
 - Streamline of workflow
 - Software validation to ensure conformance to specifications
 - Software update to incorporate changes of specifications

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Questions and Answers



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