U.S. Department of Transportation
Federal Highway Administration

QUESTIONS AND ANSWERS

Load Rating
for the FAST Act's Emergency Vehicles

REVISION R01

March 16, 2018

Office of Bridges and Structures
Federal Highway Administration
1200 New Jersey Avenue, SE
Washington, DC 20590

Executive Summary

On December 4, 2015, the President signed into law the Fixing America's Surface Transportation Act (FAST Act) (P.L. 114-94), which includes new truck size and weight provisions that effect bridge load rating and posting requirements. Among those provisions is the exemption of emergency vehicles from meeting the nationwide Interstate truck weight limits set forth in 23 U.S.C. 127(a). The emergency vehicles exempted from these weight limits by the FAST Act can create greater load effects in certain bridges than the previous legal loads. If not appropriately rated and posted (or restricted), bridge safety, serviceability, and durability might be compromised by these vehicles. Load rating and posting for all legal vehicles is mandated by the National Bridge and Tunnel Inspection Standards (NBIS and NTIS), pursuant to 23 CFR 650 subparts C and E, respectively. These legal loads now include the emergency vehicles provisions enacted by FAST Act. The purpose of this document is to provide answers to some of the common questions received from FHWA Division Offices and States prior to and after the release of *FHWA's Memorandum on Load Rating for the FAST Act's Emergency Vehicles* dated November 3, 2016 (**the Memorandum**).

Revision R01, March 16, 2018:

Revision R01 includes the following changes:

- ***Revise Question #41 to further clarify the deadlines of completion. The revised texts are in *bold italic* for addition or in ^~~double strike-through~~^ for deletion.***
- Add Question #44 to #62.
- 508 compliance

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Questions and Answers

Load Rating for the FAST Act's Emergency Vehicles

1. What is the purpose of the Memorandum?

In accordance with the National Bridge Inspection Standards (NBIS), all highway bridges on public roads must be load rated and posted (or restricted), if required, for unrestricted legal and routine permit loads (23 CFR 650.313(c)). The FAST Act made certain emergency vehicles (EVs, i.e., fire trucks) legal on the Interstate and within reasonable access to the Interstate (23 U.S.C. §127(r)). These vehicles can generate greater load effects in bridges as compared to other legal vehicles. These EVs now must be considered when load rating and posting bridges on the Interstate and within the range of reasonable access to the Interstate. Non-Interstate bridges must also be considered when load rating and posting if the State statute allows overweight EVs to cross without restrictions. The Memorandum reminds States of the load rating and posting requirements and provides further guidance on appropriate consideration of EVs in bridge rating and posting. Load rating and posting bridges for EVs will not only improve the safety of bridges for emergency responders and the traveling public, but it will also expedite the dispatch and safe movement of firefighters and fire trucks by eliminating the existing permitting and routing process. It may also result in savings, especially when emergency vehicles must move through multiple States.

2. How does the FAST Act define Emergency Vehicles (EVs)?

Pursuant to Section 1410 of the FAST Act [1], 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.

The FAST Act's EV provisions generally concern fire trucks that do not exceed the weight limits specified above. In this Q&A document, such vehicles are referred to as "FAST Act EVs."

3. Where can I find more information about FAST Act EVs?

The policy guidance issued by the FHWA Office of Operations, *Information: Fixing America's Surface Transportation Act (FAST Act) Truck Size and Weight Provisions* [2] dated February 24, 2016, provides additional guidance on the FAST Act's truck size and weight limit provisions. You may find more information about the characteristics of these vehicles from fire apparatus manufacturers and industry organizations [3].

4. From the first paragraph of the Memorandum, it seems that FAST Act EV provisions only apply to the Interstate highways and routes within reasonable access to the Interstate. Fire trucks don't operate exclusively within these limited areas. Is the Memorandum applicable to other bridges?

As discussed on Page 3 of the Memorandum, the requirements in the Memorandum apply to non-Interstate bridges if State law allows EVs to operate without restriction on those bridges.

5. Do bridges (if any) on the routes from fire departments to the Interstate need to be rated for FAST Act EVs?

Yes. Fire stations should be considered within the reasonable access limit. Refer to Question #7 for more information about reasonable access policy.

6. Where are FAST Act EVs allowed to operate freely, without a special permit?

Section 1410 of the FAST Act made the EVs described in Question #2 legal on the Interstate and on roads within reasonable access to the Interstate.

Note that a State may also allow these EVs to operate as legal loads on non-Interstate highways without a permit if (1) State law incorporate Federal definitions from 23 USC 127(r)(2) or 23 CFR Part 658 or (2) the State laws exempt these EVs from truck size and weight limitations.

7. What is reasonable access to the Interstate?

There are two types of reasonable access: 1) Reasonable access for Commercial Motor Vehicle (CMV) Size, and 2) Reasonable access for CMV Weight:

1) Reasonable access for size is defined in 23 CFR 658.19 and the September 30, 1992 Non-Regulatory Supplement to 23 CFR Part 658 as at least one road-mile from access to and from the National Network of highways, which includes the Interstate System, or further if the limits of a State's reasonable access policy for food, fuel, repairs, and rest extend to facilities beyond one road-mile. If the State does not have a FHWA-approved policy for reasonable access, it must define reasonable access as within one-road mile from the Interstate for the purposes of posting or restricting for FAST Act EVs.

2) The reasonable access requirement for weight is discussed in the September 30, 1992 Non-Regulatory Supplement to 23 CFR Part 658 and applies only to highways constructed and/or maintained by State agencies. The FHWA does not approve a State's reasonable access policy for weight. State weight-access provisions may extend the reasonable access distance beyond the minimum Federal requirements.

States most likely have one policy that addresses both size and weight.

The Division Office should obtain a copy of the State's CMV reasonable access policy(s) and the State's truck size and weight regulations for emergency vehicles (fire trucks) and work with the State to identify the bridges accessible to overweight EVs that are otherwise unrestricted.

8. If a Federal agency does not have any bridges on the NHS, and the agency's bridges are typically in remote areas and not within one mile of the NHS, must the agency rate its bridges for FAST Act EVs?

Adjacent State access policies should be examined to ensure that unrestricted EVs are not allowed to cross these bridges. If any bridge is accessible to unrestricted EVs, the bridge owner or entity which has jurisdiction over that bridge must rate and, if necessary, post (or restrict) these bridges for FAST Act EVs, pursuant to 23 CFR 650.313(c).

9. Do any references provide a summary of State exemptions to truck size and weight requirements, especially for EVs or fire trucks?

Appendix A of the *Report to Congress on Compilation of Existing State Truck Size and Weight Limit Laws* [4] provides a summary of common State statutory and regulatory exemptions and a State by State summary of truck size and weight laws, including exemptions, as of October 1, 2012.

Appendix B of the *Emergency Vehicle Size and Weight Regulation Guideline* [3] provides a summary of State truck size and weight regulations for EVs. The above documents are for reference only. Refer to the specific State's statutes and regulations for the most accurate source of information.

10. Do any references provide a summary of State CMV reasonable access policies?

Page A12 of the *2017 Motor Carriers' Road Atlas* [5] by Rand McNally provides a summary of State access policies. Refer to the specific State's original CMV reasonable access policy for the most accurate source of information.

11. Were EVs meeting the FAST Act's definition allowed to operate on the Interstate or non-Interstate highways before the FAST Act?

These vehicles might have legally operated on the highways before the FAST Act. On the Interstate System, 23 CFR 658.5 and 23 CFR 658.17(h) allow States to treat these vehicles as non-divisible loads, and allow States to issue a special overweight permit to an EV if it exceeds the weight limits set forth in 23 U.S.C. 127(a) or 23 CFR 658.17. Thus, EVs that operated on the Interstate before the FAST Act might operate legally under these State-issued permits. In addition, the State may continue to treat EVs that exceed the FAST Act limits as non-divisible loads and may issue new permits for such overweight EVs pursuant to 23 CFR 658.17(h). On non-Interstate highways, State laws apply unless that highway provides reasonable access to the Interstate, as discussed in Question #7.

12. The Memorandum states that FAST Act EVs may not meet the Federal Bridge Formula B. What is the Federal Bridge Formula B?

The Federal Bridge Formula B (FBF B) mentioned in the Memorandum was enacted by Congress in 1975 to limit the weight to length ratio of a vehicle crossing a bridge:

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

where

W = the overall gross weight on any group of two or more consecutive axles to the nearest 500 pounds;
L = the distance in feet between the outer axles of any group of two or more consecutive axles; and
N = the number of axles in the group under consideration.

See 23 U.S.C. 127(a)(2). Non-FBF B vehicles normally create worse load effects in bridges than FBF B vehicles with the same gross vehicle weight well distributed among multiple axles. For FBF B vehicles, posting bridges for gross vehicle weight is normally adequate. However, for non-FBF B vehicles, posting for both gross vehicle weight and axle weight may be necessary due to possible, significant weight shifting between axles. For more information, refer to *Bridge Formula Weight* [6], May 2015.

13. What is the potential impact of overweight EVs on highway bridges?

On most of highways, normal operation legal load limits are 20,000 lbs. on a single axle, 34,000 lbs. on a tandem axle, and 80,000 lbs. for the gross vehicle weight. The axle group weight in a normal legal vehicle is also limited by FBF B. On the contrary, FAST Act EVs are permitted to have much higher axle weight and higher gross vehicle weight than normal legal vehicles, and the axle group weight of these EVs may not comply with FBF B. In addition, not all highway

bridges were designed for such heavy loads. Therefore, allowing these heavy vehicles to operate freely across highway bridges might compromise bridge safety, serviceability, and durability.

14. How much greater are the load effects caused by overweight EVs operating on a typical bridge in comparison to AASHTO legal loads?

Consider the most common simple span girder bridges, with a span length ranging from 15 ft. to 200 ft. The moments and shears in the girder created by an EV with two single axles and a gross vehicle weight of 57,500 lbs. may be 35% greater than those caused by an AASHTO Type 3 vehicle. The moments and shears in the girder created by an EV with a front single axle, a tandem rear axle, and a gross vehicle weight of 86,000 lbs. may be 82% greater than those caused by an AASHTO Type 3 vehicle. Note that the AASHTO Type 3 vehicle is the most common single unit truck on the highways and weighs 25 tons.

15. Why is it important to include EVs in bridge load rating and posting (or restrictions)?

In addition to meeting the regulatory requirement, including heavy EVs in bridge load rating and posting (or restrictions) ensures safety and prevents damage. If not appropriately load rated and posted/restricted, these vehicles might compromise bridge safety, serviceability, and durability.

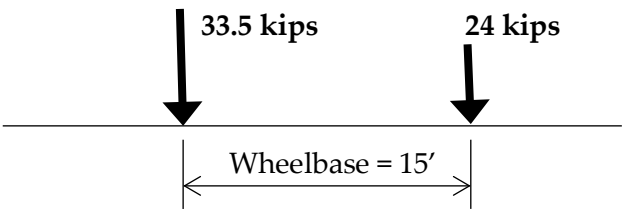
16. Does the FAST Act prescribe axle spacing or axle configuration for EVs?

Section 1410 of the FAST Act only establishes maximum single axle weight, tandem axle weight, and gross vehicle weight for EVs. It does not explicitly prescribe axle spacing or axle configuration.

17. What rating vehicle models should be used to load rate bridges for FAST Act EVs?

The Memorandum describes two rating vehicle models: EV2 and EV3.

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

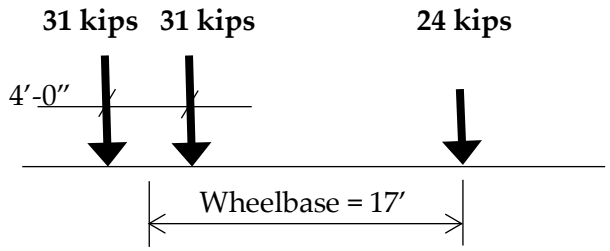


Type EV3:

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)



Type EV2 represents the EVs with two single axles, such as commercial and custom chassis pumpers, industrial foam pumpers, and certain aerial ladders.

Type EV3 represents the EVs with a front single axle and a tandem rear axle, such as commercial and custom chassis tankers, industrial foam pumpers (with a tandem axle), certain aerial ladders, and aerial platforms.

18. According to the Memorandum, bridges should be rated for Types EV2 and EV3. What if an EV has additional axles (e.g., tiller axle fire trucks)? Must such vehicles meet Federal Bridge Formula B?

Like two-axle EVs, tiller axle fire trucks need not meet the FBF B. The EV2 and EV3 configurations encompass the typical fire apparatuses used in the U.S. including EVs with tiller axles that do not exceed the FAST Act limitations. Tiller fire trucks have a much longer wheelbase and normally do not control bridge rating and posting. The number of tiller fire trucks in operation in the U.S. is very limited, and they only operate in certain metropolitan areas.

19. Since the FAST Act does not prescribe axle spacing for EVs, how did you come up with the wheelbase in the two rating vehicle models?

The *Guideline* [3] developed by International Association of Fire Chiefs (IAFC) and Fire Apparatus Manufacturers' Association (FAMA) includes a summary of typical fire apparatus configurations. For any particular type, the wheelbase is not clearly identified in the *Guideline*. However, the range of wheelbase can be reasonably estimated from the charts and information from fire apparatus manufacturers. The shortest practical wheelbase is approximately 14 ft. Commercial chassis tend to have a shorter wheelbase than custom chassis.

The FHWA Office of Bridges and Structures performed a comparative study to investigate how the wheelbase impacts the maximum moments and shears in simple span bridges. The analysis considered eight different axle configurations (four single-rear-axle load configurations and four tandem-rear-axle load configurations) and nine different wheelbases for each configuration. The table below lists the configurations used in the analysis. The axle spacing between the first and second axle varies. The second column shows the corresponding numbering (starting from 1) in Appendix A of the IAFC/FAMA *Guideline* [3].

Table 1. Axle Configurations - Emergency Vehicles

Type	FAMA	Axle 1 (kips)	Space 1 (ft.)	Axle 2 (kips)	Space 2 (ft.)	Axle 3 (kips)	L (ft.)	GVW (kips)
A21EV	1	18	14-25	31			14-25	49
A22EV	2, 5	24	14-24	31			14-24	55
A23EV	7	22.8	14-28	33.5			14-28	56.3
A24EV	-	24	14-28	33.5			14-28	57.5
A31EV	3	18	14-28	28	4	28	18-32	74
A32EV	4, 8	22.8	14-28	28	4	28	18-32	78.8
A33EV	6	24	14-28	28	4	28	18-32	80
A34EV	9, 10	24	14-30	31	4	31	18-34	86

Based on this comparative study, a 15 ft. wheelbase, single rear axle configuration and a 17 ft. wheelbase, tandem rear axle configuration encompass all the typical fire apparatus, single axle or tandem axle respectively, for the purpose of bridge load rating and posting.

20. Why does the Memorandum reference the AASHTO Manual for Bridge Evaluation (MBE), 1st Edition? This is not the current edition of the MBE. The AASHTO issued the 2nd Edition in 2011 and issued Interim Revisions afterward. Must State DOTs use the current MBE? Do the expected MBE interim revisions for 2017 incorporate the information within in the Memorandum?

The NBIS at 23 CFR 650 subpart C incorporate the MBE 1st Edition by reference, giving this edition the force of law (23 CFR 650.317). The 2nd Edition and its Interim Revisions are not binding. The 2nd Edition with Interims does not deviate substantially from the 1st Edition, except the live load factors. Use of the reduced live load factors in the 2013 Interims is allowed. The Memorandum also allows the use of a single live load factor of 1.3. We are not aware whether AASHTO has a plan to incorporate the Memorandum into the 2017 MBE Interim.

21. The multiple presence exception in the Memorandum states that if necessary, an EV needs only to be considered in a single lane of one direction of a bridge and combined with other unrestricted legal loads for load rating purpose. Can you explain this further?

To account for the low probability of side by side presence of two heavy EVs on a bridge, the load rating analysis may consider only one EV in one lane loaded simultaneously with other unrestricted legal vehicles in other lanes. This exception will reduce the computed load effects and yield higher load ratings.

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.

22. The explanation of multiple presence in the Memorandum suggests that an adjacent legal vehicle must be considered in the adjacent lane when necessary. What qualifies as necessary? Is the intention to apply an adjacent vehicle to bridges carrying multidirectional traffic, or bridges that are wide with heavy average daily truck traffic (ADTT)?

In legal load rating for normal operation legal loads, all lanes are loaded with the same legal loads, and a multiple lane presence factor is applied to compute the total load effects in consideration of the probability of side by side loading. The multiple presence exception allows the consideration of only one EV on a bridge when combining with other legal loads, which are typically not as heavy as the EV. See Question #21 above for more information.

23. Since EVs commonly travel through stopped traffic, should a lane load be considered for long or continuous spans, similar to the provisions of the second paragraph of MBE article 6A.4.5.4.1? If so, should the lane load be considered in conjunction with an adjacent vehicle? When considering the EV loads, can we apply loads in striped lanes, since EVs often travel in shoulders to maneuver around traffic?

Other than the two exceptions mentioned in the Memorandum, the AASHTO MBE 1st Edition applies. For example, a 200 plf lane load needs to be considered for spans greater than 200 ft. or continuous spans in addition to the legal trucks. However, striped lanes should not be used.

24. The Memorandum allows the use of a single live load factor of 1.3 in load rating analysis. Can you explain this further?

FAST Act EVs, same as other legal loads, may cross a bridge at maximum stresses corresponding to the operating (legal) rating level. A single live load factor of 1.3 is simple and consistent with the operating (legal) rating level. Note that for legal loads, the live load factor is 1.3 in the Load Factor Rating and from 1.3 to 1.45 in the Load and Resistance Factor Rating, depending on ADTT at strength limits state in accordance with the MBE [7].

Note that this exception for a single live load factor of 1.3 does not apply to buried structures (i.e., culverts). For buried structures, utilize the appropriate live load factor of 2.0 per MBE Article 6A.5.12.10.3.

25. A State has been rating and posting its bridges for State legal vehicles similar to the two rating load models specified in the Memorandum. If a State demonstrates that State legal vehicles envelop those two EV models, will this satisfy FAST Act EV load rating and posting requirements?

Yes. If a State can demonstrate that (1) its State legal vehicles envelop the two EV models in the Memorandum, and (2) those State legal vehicles have been included in bridge load rating and posting, this will satisfy FAST Act EV load rating requirements. However, this may be difficult to demonstrate, considering the special characteristics of FAST Act EVs, e.g., the concentrated, heavy single or tandem axle weights.

26. Does AASHTO HS 20 envelop Types EV2 and EV3? How about AASHTO H 15?

The live load moments and shears resulting from AASHTO HS 20 factored by the design live load factor (i.e., 2.17) envelop the live load moments and shears from Types EV2 and EV3 factored by the operating rating live load factor (i.e., 1.3). However, AASHTO H 15 does not envelop Types EV2 and EV3. The AASHTO H 20 may envelop Types EV2 and EV3 for shorter spans, but not for longer spans. See Figures 1 and 2 for more information.

27. Does the Memorandum effect future bridge designs?

The Memorandum has no effect on future bridge design. Note that AASHTO HL-93 design load envelops FAST Act EVs (i.e., a bridge with a HL-93 design load capacity can safely carry FAST Act EVs).

28. Which load rating methods are acceptable for load rating for FAST Act EVs?

The selection of load rating method should comply with FHWA's Policy Memorandum on Bridge Load Ratings for the National Bridge Inventory, dated October 30, 2006.

Generally speaking, utilize either the Load Factor Rating (LFR) or the Load and Resistance Factor Rating (LRFR) method.

The memorandum can be downloaded from FHWA Bridge website:

http://www.fhwa.dot.gov/bridge/nbis/103006.cfm

29. Are Assigned Load Ratings acceptable for load rating for FAST Act EVs?

Assigned Load Ratings are valid and acceptable, if the conditions in the Assigned Load Ratings memorandum dated September 29, 2011, are met. Note that AASHTO HS 20 and HL-93 envelop Types EV2 and EV3 as explained in Questions #26 and 27 for the Load Factor Rating (LFR) or the Load and Resistance Factor Rating (LRFR) method, respectively.

The Assigned Load Ratings memorandum can be downloaded from FHWA Bridge website:

http://www.fhwa.dot.gov/bridge/110929.cfm

30. Have you compared Types EV2 and EV3 to AASHTO rating vehicles in terms of the load rating factors?

Yes. As part of the comparative study to develop the rating load models, FHWA has generated a series of charts to demonstrate the relationship of load rating factors (RFs) between AASHTO HS 20, H 15, Type 3, HL-93, and Types EV2 and EV3. The charts below (Figures 1 - 4) are for informational purposes only but may assist you in screening bridge inventory for prioritization. Note that the charts are based on mid-span moments and end shears in simple span superstructure girder, and the multiple presence exemption described in the Memorandum was not considered due to unknown transverse section of the superstructure.

Figures 1 through 4 illustrate the required RF for AASHTO loads to achieve an operating RF of 1.0 for Types EV2 and EV3. If the RF of this bridge for AASHTO HS 20, H 15, Type 3, or HL-93 is greater than or equal to the required value from the chart, this superstructure will have an operating RF greater than or equal to 1.0 for the corresponding EVs. Otherwise, this bridge may require load posting.

> *Example: Given a 60 ft. simple span that has an HS 20 inventory rating factor of 0.75. From Figure 4, we can find that the required HS 20 inventory RF is 0.78 for EV3 and 0.51 for EV2. Comparing 0.75 to the required inventory RFs, FHWA can conclude that this bridge requires posting for the tandem rear axle EVs (i.e. EV3), but not the single rear axle EVs (i.e. EV2).*

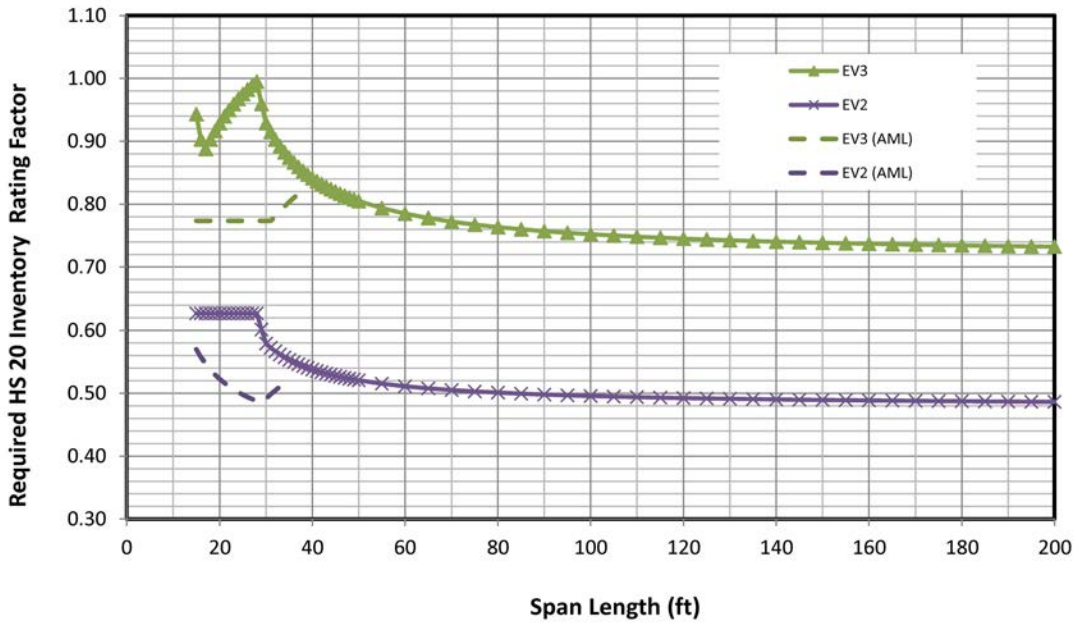


Figure 1. Required HS 20 RF to Achieve an Operating RF of 1.0 for EV2 and EV3
Note: HS 20 in the chart represents the AASHTO HS 20 Standard Truck.
(Load Factor Rating Method)

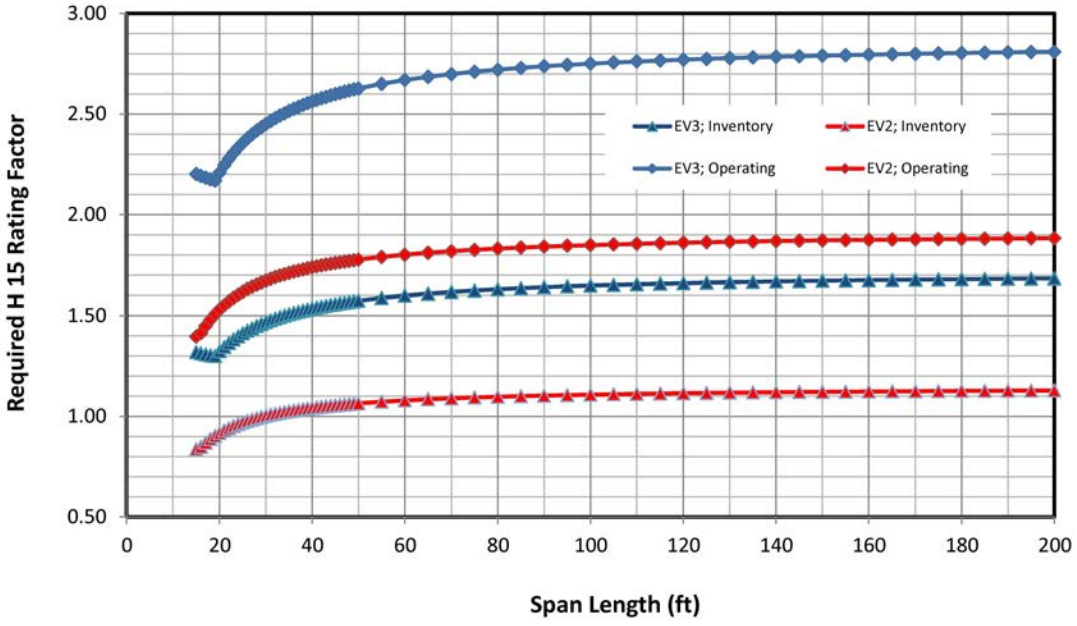


Figure 2. Required H 15 RF to Achieve an Operating RF of 1.0 for EV2 and EV3
Note: H 15 in the chart represents the AASHTO H 15 Standard Truck.
(Load Factor Rating Method)

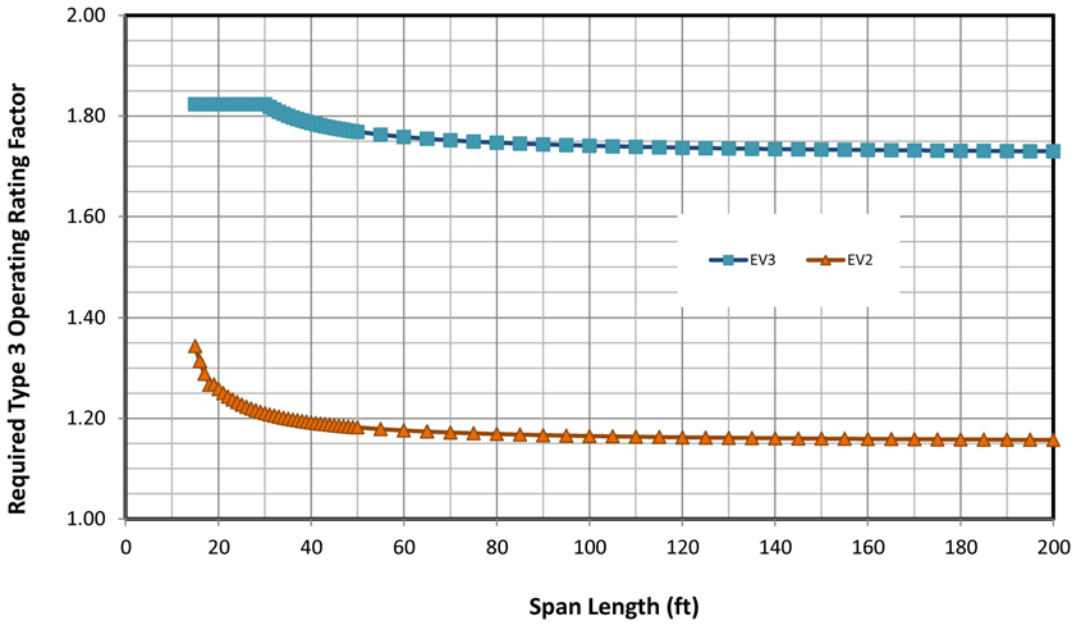


Figure 3. Required Type 3 RF
to Achieve an Operating RF of 1.0 for EV2 and EV3
(Load Factor Rating and Load and Resistance Factor Rating Method)

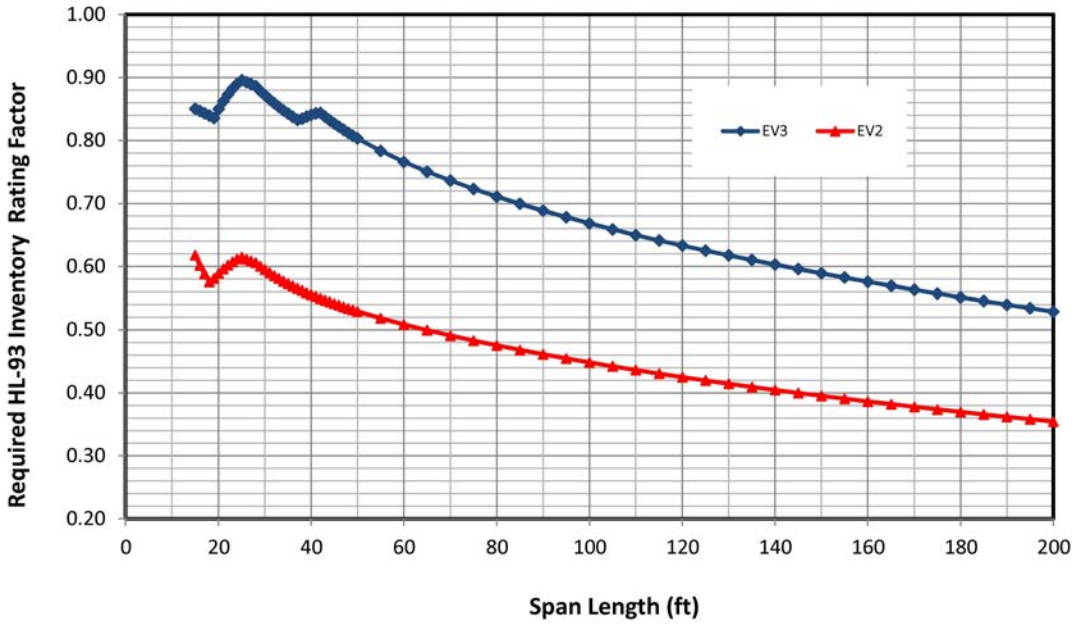


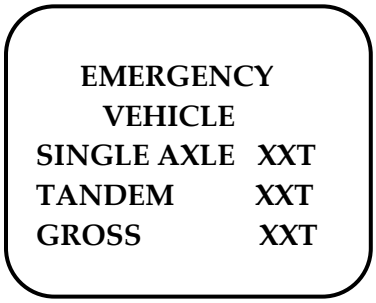
Figure 4. Required HL-93 RF
to Achieve an Operating RF of 1.0 for EV2 and EV3
Note: A live load factor of 1.3 is used for the legal load rating.
(Load and Resistance Factor Rating Method)

31. What type of load posting signs must be used?

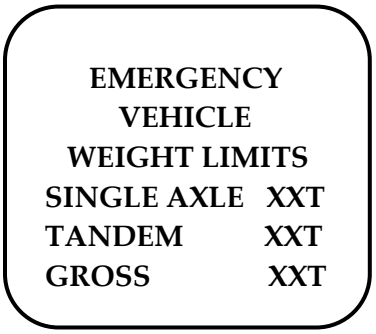
In accordance with the MBE Section 6A.8.4 or 6B.9.4, load posting signs must conform to the MUTCD. MUTCD Section 2B.59 - Weight Limit Signs presents several recommended signs, including R12-2 which restricts axle weight rather than gross weight. The example sign included in the Memorandum is a variation of R12-2 and is intended as an illustration of an MUTCD-compliant sign.

The FHWA's MUTCD Team recommended the following two posting signs that comply with the requirements set forth in the MUTCD, if appropriate text font and size are used:

Plaque that would go below an existing R12-5 sign:



Standalone Sign:



The appropriate tonnages derived from the rating load models (i.e., Types EV2 and EV3) should be listed on the plaque. Figure 5 presents a flowchart explaining how to determine the posting limits.

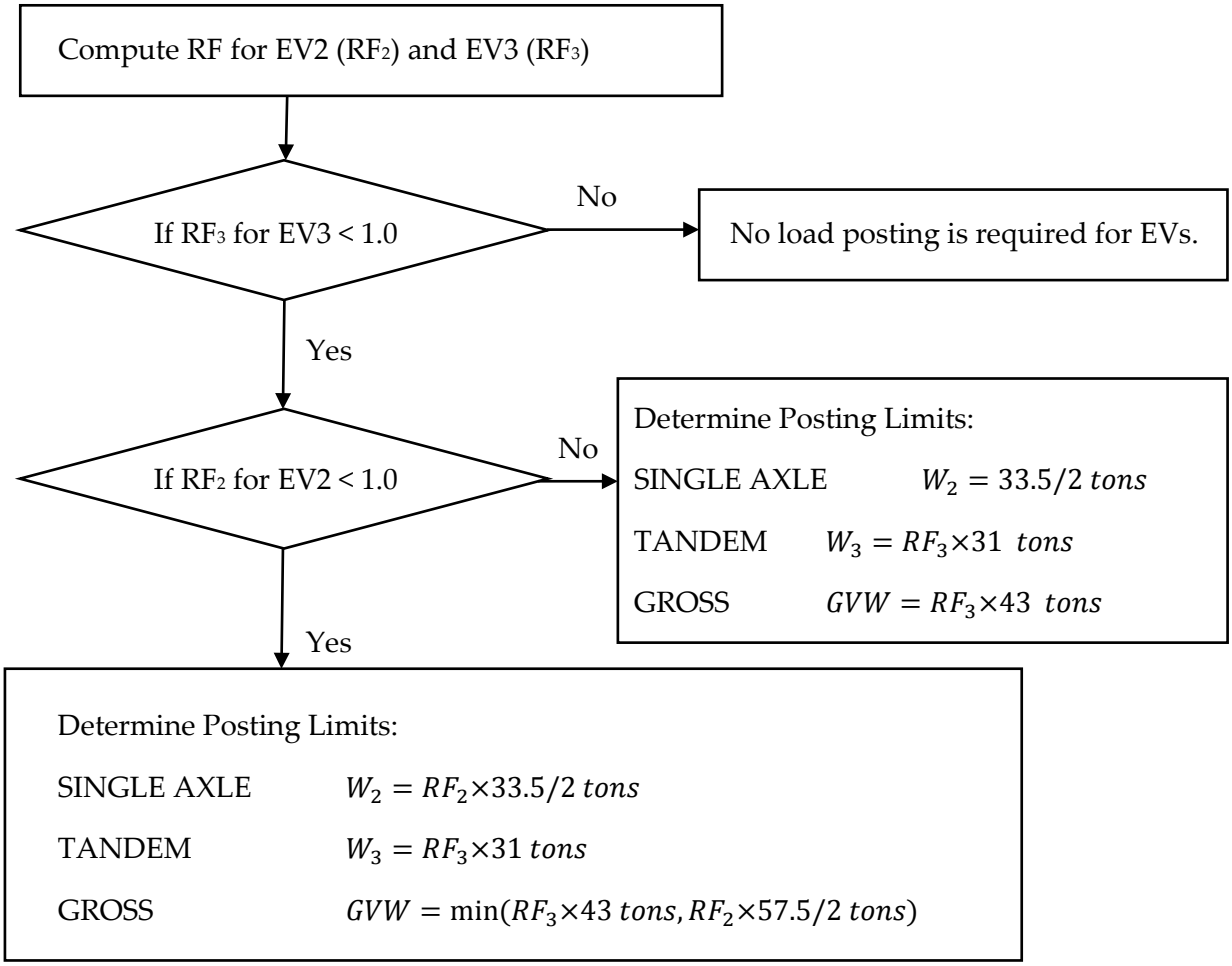


Figure 5. Posting Value Flowchart

Posting Example 1:

The load rating analysis yields a rating factor of 1.55 and 1.05 for Types EV2 and EV3, respectively. Since $F_3 = 1.05 > 1.0$*, no load posting is required for the EVs.*

Posting Example 2:

The load rating analysis yields a rating factor of 1.1 and 0.73 for Types EV2 and EV3, respectively. The safe posting weight limits may be computed by

Single axle weight limit from EV2:

$$W_2 = 1.1 \times 33.5/2 = 18.4\ tons\ \ cap\ at\ 33.5/2 = \mathbf{17\ tons}$$

Tandem axle weight limit from EV3:

$$W_3 = 0.73 \times 31 = \mathbf{22.6\ tons}$$

The gross vehicle weight limit is:

$$GVW = 0.73 \times 43\ tons = \mathbf{31.4\ tons}$$

Therefore, the following signs may be used:

Posting Example 3:

The load rating analysis yields a rating factor of 0.8 and 0.55 for Types EV2 and EV3, respectively. The safe posting axle and gross weight may be computed by

Single axle weight limit from EV2:

$$W_2 = 0.8 \times 33.5/2 = \mathbf{13\ tons}$$

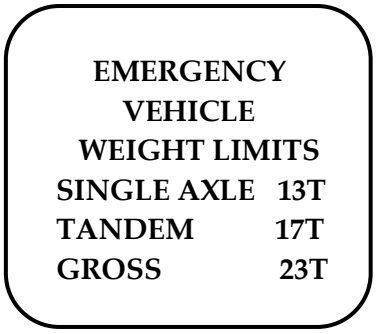
Tandem axle weight limit from EV3:

$$W_3 = 0.55 \times 31 = \mathbf{17\ tons}$$

The gross vehicle weight limit is:

$$GVW = \min(0.55 \times 43\ tons, 0.8 \times 57.5/2\ tons) = \mathbf{23\ tons}$$

Therefore, a sign below may be used:



32. Why do you recommend posting for axle weights in addition to gross weight?

In general, it is necessary to post for axle weight limit if the axle load is highly concentrated and it controls the rating. Posting for gross weight is more appropriate if the load is well distributed. As mentioned in Question #12, non-FBF B vehicles normally create load effects in bridges worse than FBF B vehicles with the same gross vehicle weight well distributed among multiple axles. For FBF B vehicles, posting bridges for gross vehicle weight is normally adequate. However, for non-FBF B vehicles, posting for both gross vehicle weight and axle weight may be necessary due to possible, significant weight shifting between axles.

Particularly for EVs with highly concentrated axle loads, posting for only axle weight or gross vehicle weight is not adequate. In other words, both axle weight and gross weight must be posted to cover all span lengths and vehicle configurations.

The following two examples illustrate the need to post for both axle and gross weight.

Example 1: Posting for Axle Weight Only

Assume the load rating analysis yields a RF of 0.8 for Type EV3. The safe load limits can be computed by

Tandem axle weight limit from EV3:

$$W_3 = 0.8 \times 31 = \mathbf{24.8\ tons} \qquad \textit{say 24 T}$$

The gross vehicle weight limit is:

$$GVW = 0.8 \times 43\ tons = \mathbf{34.4\ tons} \qquad \textit{say 34 T}$$

If posting for the tandem axle weight only, the posting sign will not prevent the following vehicle from crossing:

A single steering axle of 12 tons plus a rear tandem axle of 24 tons

This vehicle has a gross vehicle weight of 36 tons, which is not far from 34 tons.

Another vehicle with a tiller axle still does not exceed the FAST Act's limits and the tandem axle limit above:

A single steering axle of 12 tons, a rear tandem axle of 24 tons, and a tiller axle of 7 tons

This vehicle has a gross vehicle weight of 43 tons, which is (43-34)/34 = 26% over the safe gross vehicle limit computed (34 T). Therefore, this is unacceptable for longer span bridges.

Example 2: Posting for Gross Vehicle Weight Only

Use the same example above. If posting for gross weight only, the posting sign will not prevent the following vehicle from crossing this bridge:

A single steering axle of 5 tons plus a rear tandem axle of 29 tons

Thus, the tandem axle weight will be (29-24)/24 = 21% over the safe tandem axle weight limit, which is excessive and unacceptable. In this case, posting for gross weight is inappropriate and unsafe for short spans.

During the comparative study, the various configurations were compared. Results are plotted in the charts in Figures 9 through 12 for the following configurations:

Single rear axle configurations:

A21EV: Front single axle = 18 kips; Rear single axle = 31 kips; Wheelbase = 15 ft

A22EV: Front single axle = 24 kips; Rear single axle = 31 kips; Wheelbase = 15 ft

A23EV: Front single axle = 22.8 kips; Rear single axle = 33.5 kips; Wheelbase = 15 ft

A24EV: Front single axle = 24 kips; Rear single axle = 33.5 kips; Wheelbase = 15 ft

Tandem rear axle configurations:

A31EV: Front single axle = 18 kips; Rear tandem axle = 56 kips; Wheelbase = 17 ft

A32EV: Front single axle = 22.8 kips; Rear tandem axle = 56 kips; Wheelbase = 17 ft

A33EV: Front single axle = 24 kips; Rear tandem axle = 56 kips; Wheelbase = 17 ft

A34EV: Front Axle = 24 kips; Rear tandem axle = 62 kips; Wheelbase = 17 ft

Figures 6 and 7 demonstrate that the axle weight posting limit difference among A21EV, A22EV, A23EV, and A24EV, or among A31EV, A32EV, A33EV, and A34EV is about 1 ton or 4%. Figures 8 and 9 demonstrate that the gross weight difference among A21EV, A22EV, A23EV, and A24EV is about 2 tons or 7.5% in shorter spans, and the gross weight difference among A31EV, A32EV, A33EV, and A34EV is about 2 tons or 5% in shorter spans. The differences in the gross weight limit become much smaller as the span length increases.

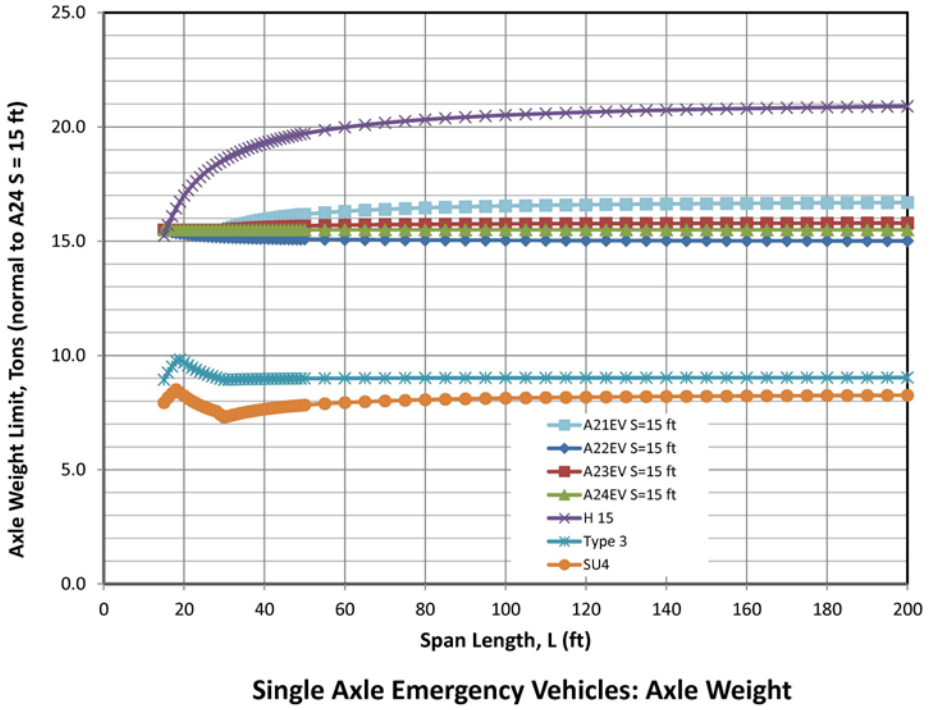


Figure 6. Axle Weight Limits – Single Rear Axle EVs

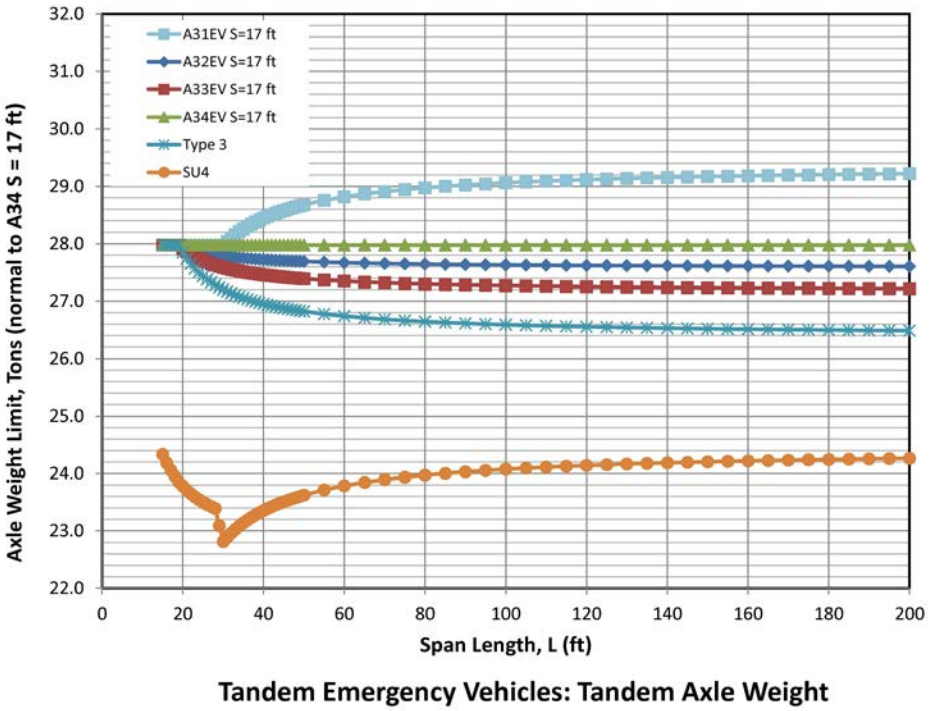


Figure 7. Axle Weight Limits – Tandem Rear Axle EVs

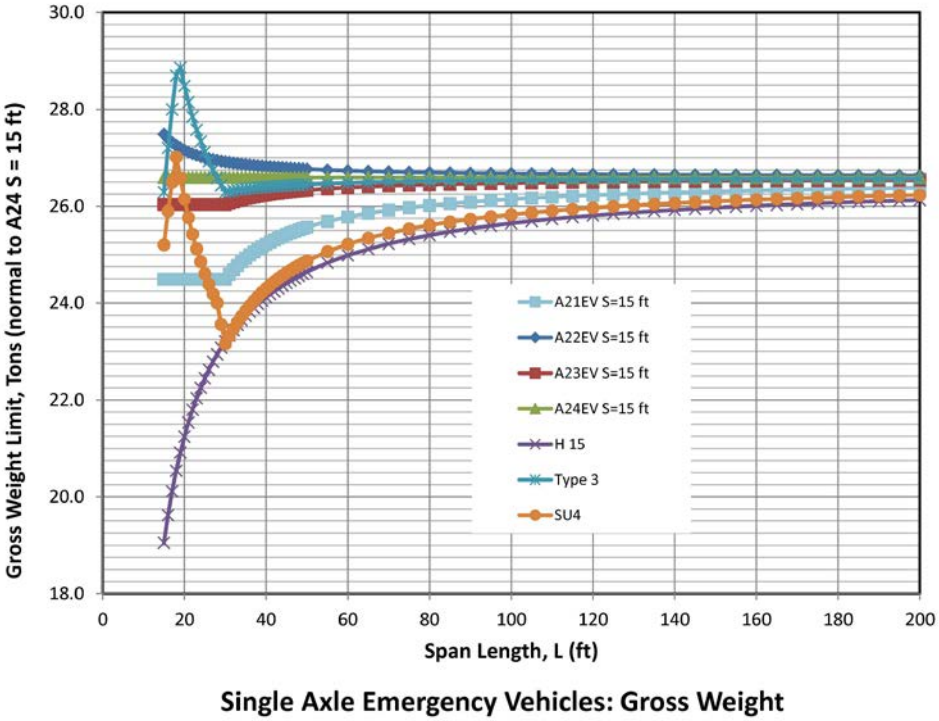


Figure 8. Gross Weight Limits – Single Rear Axle EVs

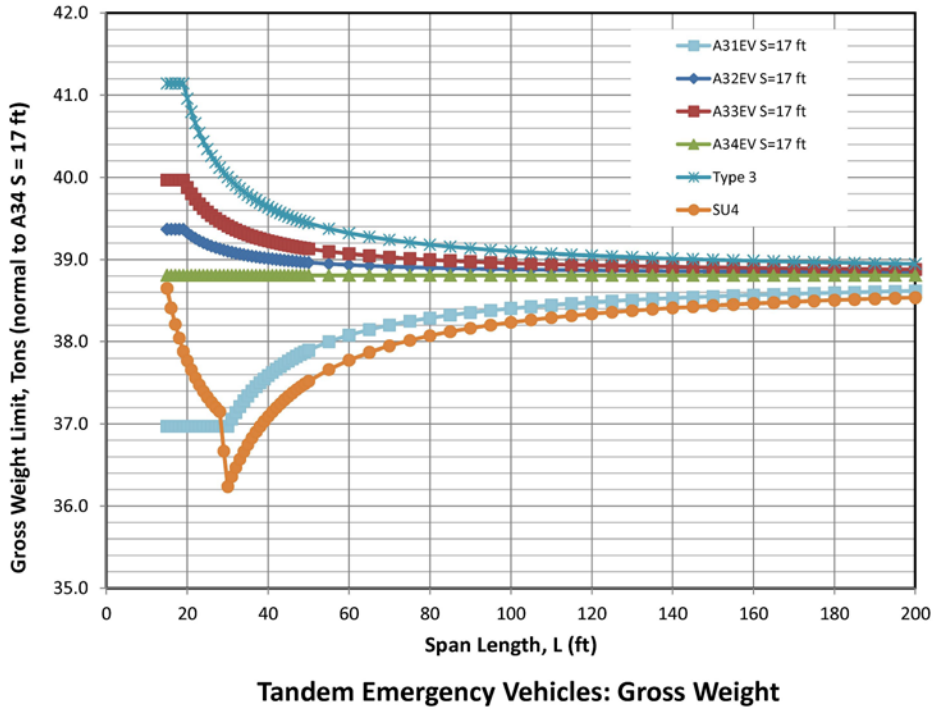


Figure 9. Gross Weight Limits – Tandem Rear Axle EVs

To be consistent for all span lengths, vehicle configurations, and structural conditions, load should be posted for both axle weights and gross weight. This study demonstrates that only posting for axle weights is appropriate for both very short spans where the axle weight dominates or for high structural capacity having a RF close to 1.0, whereas only posting for gross weight is appropriate for longer spans where the gross weight controls.

33. Can we remove "Emergency Vehicle" from the post signs in the examples above?

No, you should not. Explicitly listing the "Emergency Vehicle" clearly identifies the target of this sign—FAST Act EVs.

34. State code does not allow posting weight limits for a fire apparatus. How should a State address this situation?

If FAST Act EVs are legally allowed to cross a bridge without special permits or other weight restrictions, and the bridge is rated inadequate to carry those EVs, the bridge must be posted for weight in accordance with the NBIS (23 CFR 650.313(c)). To address this situation, the State must either (1) revise the State law to allow weight posting for FAST Act EVs or (2) apply restrictions to those EVs, such as requiring special permits. Note that the FAST Act made FAST Act EVs legal on the Interstate System and the routes within the reasonable access to the Interstate. Therefore, States cannot require special permits for FAST Act EVs to cross bridges on the Interstate and within reasonable access to the Interstate.

35. Fire departments have requested permits to travel through a State. This State does not require permits for these vehicles, but operators often apply for permits anyway because they know that their trucks are heavy and do not want to damage the highway. Can the State require permits for these vehicles instead of posting bridges to address this issue?

For bridges not on the Interstate System and beyond reasonable access to the Interstate, each State may choose how to revise its law to either allow posting for FAST Act EVs or require permits or restrictions. As mentioned in the previous question, States cannot require permits for these EVs to cross bridges on the Interstate and within reasonable access to the Interstate since the FAST Act permits these vehicles to operate on these bridges.

36. Does the Memorandum assume that the States will provide the necessary education and outreach to fire departments statewide? For example, should States assume that a fire truck operator will understand what the EV weight limit sign means?

To ensure effective bridge load posting, States should provide education and outreach to fire departments, operators of large equipment, and law enforcement.

37. The ability for a fire department to respond as quickly as possible is the key to saving lives. How do roadway authorities fully implement the Memorandum without grossly impeding a fire department's emergency response time?

The implementation of the Memorandum will require a combination of new load rating analysis; installation of posting signage; enforcement, routing and permitting; coordination with local fire departments; and, in some cases, bridge strengthening or replacement to improve access. The Memorandum does not impede emergency response, since EVs were not permitted to cross bridges with insufficient capacity prior to the FAST Act.

Roadway authorities such as States, counties, and townships should coordinate on a regular basis with local fire departments and vehicle manufactures on where the load posted bridges are located. For example, a State may consider publication of a map showing bridge capacities and restrictions for FAST Act EVs and make the publication available to fire departments. In addition, these roadway authorities may consider permitting schemes on load posted bridges. Fire departments should consider the capacity of bridges in their service area when purchasing new or used fire equipment. Fire departments may consider asking other fire departments to service areas with load posted bridges if the response times are shorter from those locations.

38. Historically, have fire trucks caused collapsed or partially collapsed bridges? Can we assume that fire departments have enough truck weight knowledge to avoid the most vulnerable weight-restricted bridges within their jurisdictions?

Since no national bridge failure database exists, FHWA is unable to track the history of bridge collapses caused by fire trucks. Currently, no specific national standards or training programs are available to ensure that fire departments have sufficient knowledge of truck weight and bridge capacity. State and local road authorities should provide fire departments with education and outreach on this topic.

39. Does the Memorandum assume that State laws must be changed to abide by these EV weight limit signs? State law currently exempts fire trucks from any load limit/posting signs, which would include an EV weight limit sign without a State law change.

Changes in State law may be required in order to implement the FAST Act truck size and weight provisions explained by the Memorandum.

As stated in Question #34, State law must either (1) be revised if necessary to ensure compliance with FAST Act EV weight posting requirements or (2) otherwise restrict overweight EV operations, such as by requiring special permits on non-Interstate routes beyond reasonable access to the Interstate.

40. Instead of posting a load limit for FAST Act EVs, can a State restrict the bridge by notifying fire departments of bridges that cannot safely carry these vehicles?

The NBIS/NTIS requires load posting or "load restriction" if a bridge does not have adequate capacity to carry unrestricted legal or routine permit loads. The regulation and the AASHTO MBE do not provide clear guidance on load restriction other than hauling permits. Notification may be considered acceptable load restriction if the State agency can demonstrate that the proposed method is enforceable and effective at preventing EVs from crossing a bridge that cannot safely carry them.

Regarding the operation of EVs in multiple States (either in drive-away operations or in response to emergency situations in other States), FHWA considers posting to be the most effective method of load restriction for bridges on the Interstate and within the reasonable access to the Interstate.

Simply put, States should use load posting for bridges on the Interstate and within reasonable access to the interstate; States should consider using either load posting or effective load restrictions, such as permitting or other means, for non-Interstate bridges beyond points of reasonable access. State transportation authorities should conduct education and outreach to fire departments to ensure the effectiveness of load posting or restriction.

41. *(Revision R01, March 16, 2018)* What are the timelines for load rating for FAST Act EVs?

As stated in the Memorandum, bridges in Group 2 should be rated for FAST Act EVs following their next inspection, but no later than December 31, 2019. Bridges in Group 1 do not need to be rated for FAST Act EVs at this time. However, bridges in either group must be rated for FAST Act EVs whenever a normal re-rating is warranted to comply with the NBIS (23 CFR 650.313(c)). **^**~~Re-rating is warranted following changes in structural condition and/or other factors that impact live load capacity.~~**^**

If a State ^~~adopts~~^ ***has adopted**** the FAST Act's emergency vehicle provision into State law or exempts EVs meeting the definition under the FAST Act from load rating requirements, allowing them to operate legally on non-Interstate highways, any non-Interstate bridges that carry FAST Act EVs must also be load rated and posted/restricted (if necessary) for FAST Act EVs. In this situation, ***States should complete evaluations and load ratings of bridges not on the Interstate and not within reasonable access to the Interstate by December 31, 2022. The FHWA Division Bridge Engineer should consult with his or her Bridge Safety Engineer in other situations.**** ^~~the FHWA Division Bridge Engineer should consult with his or her Bridge Safety Engineer.~~^

As mentioned in the Memorandum, each FHWA Division Offices should ***have an action plan in place with its State DOT or Federal agency partners**** ^~~work with its State DOT or Federal agency partners to develop an action plan by March 31, 2017~~.^

42. Does the Memorandum apply to highway tunnels?

Yes. States and Federal agencies should load rate applicable highway tunnels for the EVs by December 31, 2019, as stated in the first paragraph of Page 4 in the Memorandum.

43. Who should States contact for assistance?

The FHWA Division Bridge Engineer is the first level of contact. If necessary, FHWA's Office of Bridges and Structures and Resource Centers will assist the Division Bridge Engineer.

44. *(Revision R01, March 16, 2018)* Are the EV2 and EV3 real loads? What is the tire contact area to use?

The EV2 and EV3 meet the FAST Act definition for emergency vehicles under 23 U.S.C. 127(r)(2) and are the enveloping loads representative of real fire trucks for bridge load rating and posting purpose. Since the EV2 and EV3 are representative loads, the tire contact area specified in the AASHTO LRFD Article 3.6.1.2.5 may be used, in lieu of better information.

45. *(Revision R01, March 16, 2018)* Can a State determine that some exits along the Interstate are so remote that there are no facilities for food, fuel, repairs, or rest within reasonable access at that exit, therefore, load rating of bridges within one-road-mile from the Interstate is not required for the EVs?

No, the State cannot. If unrestricted EVs can cross any bridges allowed by State law, States must rate and post/restrict (if necessary) those bridges for the EVs. See Question #7 for the reasonable access and Question #5 for the bridges on route from fire stations to the Interstate.

46. *(Revision R01, March 16, 2018)* In general, as the weight increases, the dynamic impact decreases; the slower a vehicle travels, the lower its dynamic impact. What impact factor or dynamic allowance should be used when evaluating the EVs? Is the speed posting still an option?

Since available data is insufficient to suggest a reduced impact factor or dynamic allowance for the EVs, the impact factor or dynamic allowance specified in the AASHTO MBE for normal legal loads should be used. Posting for a reduced speed to alleviate dynamic impact might not be a valid option for the EVs based on the practicality of self-enforcement, especially on the Interstate where speed reductions could create other safety concerns.

47. *(Revision R01, March 16, 2018)* The Memorandum states that a live load factor of 1.3 may be used. Why was 1.3 selected as opposed to other value(s)? Was the chosen live load factor of 1.3 calibrated for a uniform reliability?

The live load factor was 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.

48. *(Revision R01, March 16, 2018)* Should the EVs be treated as divisible or non- divisible vehicles?

The EVs that meet the FAST Act limitations in 23 U.S.C. 127(r) are legal loads and do not require a permit to operate on the Interstate and within reasonable access. Any EVs that exceed the FAST Act limitations may still be treated as non-divisible loads for overweight permits.

For non-Interstate or beyond reasonable access, State law applies.

49. *(Revision R01, March 16, 2018)* Question #31 provides schematics of posting signs for the EVs. Did the FHWA MUTCD Team design new signs for the EVs?

The FHWA MUTCD Team has developed two new posting signs for the EVs, R12-7 and R12-7aP. The R12-7 sign is for independent use; the R12-7aP plaque is for use only in a sign assembly below a primary regulatory Weight Limit sign (see MUTCD § 2B.59).

50. *(Revision R01, March 16, 2018)* Since the tandem axle is only on the EV3, if the single axle limit was governed by the EV2 rather than the EV3, would the gross limit for the R12-7 or 12-7aP sign be for the EV2?

See Question #31 (Figure 5. Posting Value Flowchart) for the procedure to determine the posting limits. When a bridge needs to be posted for a reduced single axle weight based on the EV2, the posted gross vehicle weight is probably governed by the EV2.

51. *(Revision R01, March 16, 2018)* A agency has some bridges currently posted at an operating load limit of 3 tons using R12-1 signs. Does the agency need to load rate those bridges for the EVs?

For a bridge currently posted at an operating load of a very low tonnage such as 3 tons, the EVs would not pass the load rating as by observation. As such, the EVs cannot use the bridge. In lieu of a load rating analysis for the EVs, it would be acceptable to add a note to the bridge file stating that by observation, emergency vehicles do not rate out and are not allowed to use the bridge based upon the existing low operating rating/posting.

52. *(Revision R01, March 16, 2018)* A State has historically posted gross vehicle weight and not axle weight. In lieu of utilizing the recommended posting sign R12-7 or R12-7aP for emergency vehicles, can the State use the regular posting signs (such as R12-1, R12-5) to restrict all vehicles that exceed those posted weights?

Yes, it is acceptable to use a weight posting sign in lieu of R12-7 and R12-7aP with the following two conditions: 1) the posting limits on the sign are justified to be appropriate (generally conservative) in restricting the passage of the EVs; and 2) State law does not exempt the EVs from obeying the weight posting signs. However, for consistency and uniformity, it is strongly recommended that R12-7 or R12-7aP be utilized for bridges on the Interstate or within reasonable access.

53. *(Revision R01, March 16, 2018)* Are the EVs restricted from crossing bridges when vehicle gross or axle weights exceed the bridge's weight limits currently posted for normal legal loads?

Yes. For bridges on roads governed by State law, State law applies. Those bridges carrying the EVs legally must be load rated for the EVs; bridges with insufficient capacity to carry the EVs must be posted or restricted to ensure safety. The posted weight limits on the current sign might need to be modified or additional R12-7aP plaque might need to be installed.

For bridges on the Interstates or within reasonable access, the EVs must obey bridge load posting signs.

54. *(Revision R01, March 16, 2018)* If a bridge is currently load posted below legal limits, do we still need to re-rate it for the EVs?

Yes, load rating is required to justify that the currently posted weight limits are appropriate for the EVs. If necessary, the posted weight limits on the current sign might need to be modified or an additional R12-7aP plaque might need to be installed. For bridges currently posted at very low weight limits, see Question #51.

55. *(Revision R01, March 16, 2018)* A State performed a high-level evaluation of its bridge inventory using some basic parameters. The results showed that many bridges may require load posting for the EVs. Does the State need to post all those bridges?

The estimated number of bridges depends on the parameters used in the screening. If using the thresholds in the Memorandum and the NBI Item 64 or 66, States may find that 10-20% non-Interstate bridges do not have the operating capacity to carry the EV3. Through further detailed load rating analysis of individual bridges, States may conclude that some of those bridges do not require load posting.

56. *(Revision R01, March 16, 2018)* If a bridge does not require load posting for legal loads other than the EVs, how should NBI Item 41 be coded for this bridge?

The bridge should have a code of "P" for NBI Item 41.

57. *(Revision R01, March 16, 2018)* When coding NBI Item 70 for bridges that were not previously posted, but will now be posted for the EVs, should the EVs be included?

Yes. If a bridge needs to be load posted for the EVs, the EVs must be included when coding NBI Item 70. In other words, any bridge requiring load posting for the EVs should have a code of 4 or less for NBI Item 70.

58. *(Revision R01, March 16, 2018)* If a bridge is to be posted with multiple signs, such as a R12-5 plaque for normal commercial legal vehicles and a R12-7aP plaque for the EVs, will the multiple signs confuse the public?

States are required to post bridges in accordance with the AASHTO MBE and signs must comply with the MUTCD. It is inevitable that in some instances there will be multiple signs at a bridge location. Outreach and education with the industry may help alleviate the confusion.

59. *(Revision R01, March 16, 2018)* Fabricating and installing load posting signs for the EVs will place an additional cost burden on States. Is this an eligible expense in the Federal-aid program?

Yes. Both the NHPP and STBG programs allow the use of Federal funds for the inspection and evaluation of bridges and tunnels. Load rating and posting falls under the category of evaluation. Therefore, NHS bridges can use NHPP and any bridges can use STBG funds to pay for load rating and posting to meet the requirements of NBIS/NTIS.

60. *(Revision R01, March 16, 2018)* Can a State DOT issue a trip (special) permit for an emergency vehicle to pass a bridge posted for the FAST Act EVs if the State DOT can prove that the bridge has adequate capacity to carry this emergency vehicle by refined analysis, speed control, or other acceptable means?

If Federal weight laws apply, a State may issue special permits for a vehicle to cross a load posted bridge (over the posted load limit) if their State laws and procedures allow.

For non-Interstate or beyond reasonable access, State law applies.

61. *(Revision R01, March 16, 2018)* Can a State DOT issue a trip or routine permit for a non-EV overweight vehicle to pass a bridge only posted for the EVs?

Yes, unless State laws or procedures do not allow it.

62. *(Revision R01, March 16, 2018)* A State issues permits and does not route vehicles over posted bridges. If a bridge is posted for the EVs only, the State's permitting agency would not be able to distinguish this and thus would not allow permit loads to cross this bridge. How will the State address this potential permitting process issue that could affect commerce in the State?

Appropriately distinguishing the load posting for the EVs from the load posting for normal legal loads will eliminate this issue. If the State uses NBI Item 41 when permitting overweight loads, the State may consider creating a State Item to identify those bridges requiring load posting only for the EVs. The State may also need to amend its routing/permitting procedure.

64. References

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[2]. FHWA Office of Operations, *Information: Fixing America's Surface Transportation Act (FAST Act) Truck Size and Weight Provisions*, February 24, 2016

[3]. International Association of Fire Chiefs and Fire Apparatus Manufacturers Association, *Emergency Vehicle Size and Weight Regulation Guideline*, 2011

[4]. Federal Highway Administration, *Report to Congress on Compilation of Existing State Truck Size and Weight Limit Laws*, May 2015

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[6]. Federal Highway Administration, *Bridge Formula Weight (revised)*, May 2015

[7]. AASHTO, *Manual for Bridge Evaluation*, First Edition, 2008; Second Edition, 2011; and Interim Revisions.

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