27. Load Rating and Posting

27.1. Load Rating
27.2. Load Posting

27.1. Load Rating

Load rating bridges is an important function of the DOT&PF Bridge Section. It allows the evaluation of existing structures in a comparative manner.

Bridges designed to former standards are compared to contemporary standards, in conjunction with an appraisal of the bridge condition, through the Inventory Rating. The Operating Rating is used to evaluate permit overloads on structures.

FHWA requires the evaluation of the Inventory Rating and the Operating Rating for every bridge structure. Bridge owners report these values to FHWA annually when reporting other required NBI data.

27.1.1. Definitions

§650.305 of the NBIS defines load rating as:

"The determination of the live load carrying capacity of a bridge using bridge plans and supplemented by information gathered from a field inspection."

In addition, the following definitions apply:

Inventory Rating: The load level that can safely use an existing structure for an indefinite period of time.

Operating Rating: The maximum permissible load level to which the structure may be subjected for the load configuration used in the rating.

27.1.2. Responsibilities

The Bridge Section is responsible for determining the load-carrying capacities of all non-federal publicly owned and maintained bridges in the state of Alaska that are open to the public. The DOT&PF procedures and methodology as presented in Section 27.1 meet all NBIS requirements.

Bridge inspectors must load rate those bridges that have noted any physical changes from the previous inspections that affect structural capacity. In addition, the bridge engineer must load rate all new designs. The bridge engineer submits this load rating to the Bridge Management Unit after approval of shop drawings and prior to opening to traffic.

The Bridge Section determines the need for load posting of all state-owned bridges. The Chief Bridge Engineer orders that such bridges be posted. For non-state bridges, the DOT&PF recommends to the owner the appropriate load posting for bridges under its jurisdiction.

Load rating files, including calculations, are located in separate files in the Bridge Management Unit. Where calculation files are large, the cover sheet is copied and placed in the load rating file with instructions indicating where the complete report may be found.

Load posting recommendations are included in the load rating files.

27.1.3. Methodology

There are three methods for bridge evaluation included in the AASHTO *Manual for Bridge Evaluation* (MBE):

1. Allowable Stress Rating (ASR),
2. Load Factor Rating (LFR), and
3. Load and Resistance Factor Rating (LRFR).

Load rate steel and concrete bridges using the LFR method and timber bridges using the ASR method. In addition, load rate new and replacement bridges designed with the HL-93 load using the LRFR method.

DOT&PF policy is that all critical bridge members be load rated (e.g., decks, girders, floorbeams, stringers, hangers, damaged members, gusset plates, culverts) and that load ratings include values for moment, shear and, where applicable, axial stresses.

The rater must specify live load type, placement for maximum stress, distribution, and impact. Include the following cases for all LFR load ratings:

- inventory with multiple lanes and impact included
- operating with multiple lanes and impact not included
- operating with one lane centered on the bridge and impact not included

27.1.4. Thresholds for Re-rating Existing Bridges

Bridges must be re-load rated when a bridge inspection reveals a quantifiable change in the bridge

condition (e.g., increased metal section loss) or change in loading (e.g., change in wearing surface thickness greater than 1 inch, addition of a utility greater than 12 inches in diameter).

The Bridge Management Unit is responsible to ensure bridges are re-load rated but, in most cases, the inspectors complete the load rating in consultation with the Bridge Management Unit.

27.1.5. Load Rating Practices

DOT&PF standardized procedures regarding LRFR load ratings are still under development. For interim procedural recommendations, contact the Bridge Management Unit.

DOT&PF has adopted the following practices for ASR and LFR load ratings of bridges in conjunction with the *AASHTO Standard Specifications for Highway Bridges 17th Edition*, unless otherwise noted:

1. Evaluate both interior and exterior girders.
2. Do not consider deflection in the load rating of structures.
3. Concrete stresses will be as per the as-built plans and specifications. The rater may increase the 28-day strength value of cast-in-place members by 25 percent to account for aging when the in-situ concrete is a minimum of five years old and all evidence shows it is completely sound.
4. In cases where the LFR cast-in-place deck rating requires posting per Section 27.2.1, calculate the moment live load with the LRFD Specifications equivalent strip method (Articles 4.6.2.1.3 and 4.6.2.1.6). In the event that the LRFR live load moment is less than the LFR live load moment, reevaluate the LFR load rating with the revised live load. Report a separate load rating for each live load method.
5. Use the lever rule to calculate the distribution factor if the lever rule value is less than the distribution factor from Table 3.23.1 or "S/D."
6. Where a pedestrian walkway is separated by a traffic barrier, add an additional lane of traffic when determining "D" in Article 3.24.3.
7. In prestressed girders, check for the minimum shear value from h/2 to midspan.
8. The stress in the prestressing strands shall be linearly varied from 0 ksi to f_{pe} in a distance of 50 diameters from the end of girder (25 inches for ½-inch diameter strands). If this transfer length extends past h/2 from the support, it must be included in the load rating.
9. Use the stress in prestressing strands after all losses shown on the plans. Assume 45 ksi for all losses if no value exists and the bridge was designed to or prior to the *AASHTO Standard Specification for Highway Bridges 17th Edition.* Otherwise, calculate losses according to Section 14.4.2.
10. Increase the live load shear in girders according to Section 13.1.2.
11. When calculating either the Inventory or Operating Rating for bulb-tee girders, use the distribution factor "D" in the concrete beam formula in Article 3.23.4. Determine J utilizing the equation for stocky open sections provided in the current *LRFD Specifications*. Historically, K = 2.2 has been used for load rating as the equation for J was not adequately defined. When an LFR load rating is updated per Section 27.1.4, revise the K value.
12. For prestressed girders, use the average stirrup spacing for shear ratings. See Section 6A.5.8 of the current *Bridge Manual for Evaluation* for guidance where $d_v = d$ and $\theta = 45$ degrees.
13. In cases where the LFR shear load rating is governed by the term $V_s = 8\sqrt{f'_c}b_w d$ in Article 9.20.3.1 of the *AASHTO Standard Specification for Highway Bridges 17th Edition*, substitute the *LRFD Specifications* term $V_n = 0.25f'_c b_v d_v \underline{+V_p}$ (LRFD Eq. 5.~~8~~7.3.3-2) as the limiting equation.
14. For prestressed girders, use a maximum effective flange width of 96 inches for calculating section properties and the full flange width for dead load calculations. Historically, 84 inches had been used for load ratings but was updated to reflect current design practices.
15. When utilizing Equation 10-129c for composite sections, use the following equations consistent with the first yield of the *LRFD Specifications.*

$$M_u = \frac{5M_p - 0.85F_yS_{x,n}R}{4} + \frac{0.85F_yS_{x,n}R - M_p}{4}\left(\frac{D_p}{D'}\right) \geq M_{y1}$$

where:

$$M_{y1} = S_{x,n}\left[RF_y - \frac{1.3M_{DC1}}{S_{x,steel}} - \frac{1.3M_{DC2}}{S_{x,3n}}\right] + 1.3M_{DC1} + 1.3M_{DC2}$$

$S_{x,steel}$ = steel only section modulus
$S_{x,n}$ = short-term composite section modulus
$S_{x,3n}$ = long-term composite section modulus

16. In composite bridges, calculate the effective flange width as the minimum of the following:

    a. Interior Girder, $(b_{eff})_{interior}$

        1) girder spacing
        2) span length / 4
        3) 12 * slab thickness + 0.5 * top flange width

    b. Exterior Girder, $(b_{eff})_{exterior}$

        1) 0.5 * $(b_{eff})_{interior}$ + overhang width
        2) 0.5 * $(b_{eff})_{interior}$ + span length / 8
        3) 0.5 * $(b_{eff})_{interior}$ + 6 * slab thickness + 0.25 * top flange width

    For further information see Article 4.6.2.6 of the 2006 Interim Revisions of the *AASHTO LRFD Bridge Design Specifications*, 3rd Edition.

17. Evaluate log bridges in accordance with the publication "Design Guide for Native Log Stringer Bridges," USDA, Forest Service, Region 10, by Frank Muchmore.

18. When load rating timber decks, use wet-use stress in all cases. Evaluate other timber members with wet-use stresses in the marine and transitional climatic zones. Structures in the continental and arctic climatic zones may use dry-use stresses. Review bridge inspection reports for specifics on the moisture condition of individual members.

19. If the grade and species of a sawn timber member is unknown, assume Douglas Fir No. 2 for that member's strength properties unless the member is creosoted. For creosoted timber assume Douglas Fir No. 1 or Douglas Fir No. 1 & Btr.

20. Following the *AASHTO Manual for Bridge Evaluation* Articles 6A.2.3.4 and 6B.6.2.4, do not include pedestrian loading simultaneous with vehicular loads. Where significant pedestrian loading is expected to coincide with the maximum vehicular loading, consult with the Chief Bridge Engineer, Bridge Management Engineer, or Load Rating Manager prior to including pedestrian loading. Do not include pedestrian loading in one lane centered operating ratings discussed in Section 27.1.3.

21. Load rate all members at critical sections. Document any unusual circumstances and assumptions made.

27.1.6. Dimensions

Use the dimensions as shown in the shop drawings, as-built drawings, and construction drawings unless field-measured dimensions deviate significantly from the plan dimensions or there are no plans.

The rater may reduce the structural section properties of a deteriorated component based on field measurements and engineering judgment as derived from an inspection of the bridge.

27.1.7. Load Rating Quality Control (QC) Procedures

Perform load ratings in accordance with the AASHTO *Manual for Bridge Evaluation* and Section 27.1.

All load ratings will be independently reviewed for reasonableness and general conformity with the state's load rating practices. On the Load Rating Summary Sheet, the reviewer will note "Reviewed for Conformity" and sign each load rating reviewed.

A minimum of 10 percent of all bridges load rated in a calendar year will receive an independent load rating check, using independently developed assumptions.

A 10 percent difference in the calculated live load, dead load, nominal capacity, and equivalent HS values is considered acceptable. Reconcile discrepancies to meet these requirements. The more conservative equivalent HS value is reported.

Axle Group	Total Group Weight (kips) [1]	Minimum Spacing (ft)
Single	20.0	-
Tandem	38.0	3’-6”
Triple – Option 1	42.0	3’-6”
Triple – Option 2	43.5	5’-0”
Triple – Option 3	45.0	6’-0”
Quad	50.0	3’-6”

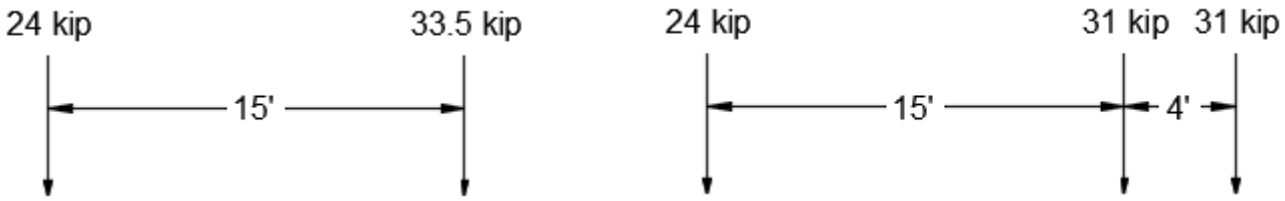
[1]*Distribute weights evenly to each axle.*

Table 27-1
Posting Axle Groups

Axle Group	Total Group Weight (kips) [1]	Minimum Spacing (ft)
Single	33.5	-
Tandem	62.0	4’-0”

[1]*Distribute weights evenly to each axle.*

Table 27-2
Emergency Vehicle Axle Groups



EV2 **EV3**

Figure 27-1
Emergency Vehicles

27.2. Load Posting

27.2.1. Thresholds for Posting Existing Bridges

When the LFR Operating Rating is equal to or less than 3 tons, then the bridge owner must close the bridge.

The rater must evaluate a bridge for posting when a concrete deck has a LFR Inventory Rating less than HS12.5 (RF < 0.625).

The rater must evaluate a bridge for posting when a timber deck or an orthotropic steel deck has a LFR Inventory Rating less than HS15 (RF < 0.75).

The rater must evaluate a bridge for posting when a critical member, other than the deck, has a LFR Inventory Rating less than HS15 (RF < 0.75).

The rater must evaluate a bridge for Emergency Vehicle (EV) posting when a critical member, including decks, has a LFR Inventory Rating less then HS20 (RF < 1.0).

27.2.2. Loads for Posting

The following applies:

1. **Decks.** A single axle controls. The posting should be for the maximum axle weight that the deck can carry at its LFR Inventory Rating. Base posting on a 20-inch tire width.

2. **Stringers, Girders, Floorbeams, etc.** Evaluate for probable legal load configurations consisting of a single, tandem, triple, and quad axle groups (See Table 27-1). In addition, evaluate the posting loads in the current *Manual for Bridge Evaluation*. Post the structure for each axle and vehicle configuration that exceeds the critical-member capacity based on the LFR Inventory Rating.

3. **Emergency Vehicles.** Evaluate for emergency vehicles for the legal load configurations consisting of a single axle group, tandem axle group, EV2 vehicle, and EV3 vehicle (See Table 27-2 and Figure 27-1). Post the structure for each axle configuration and the minimum gross vehicle weight that exceeds the critical-member capacity based on the LFR Operating Rating with multiple lanes loaded and impact. This is consistent with the FHWA *Questions and Answers – Load Rating for FAST Act's Emergency* Vehicles, Revision R01, March 16, 2018.

4. **Limit States.** Only post for strength limit states. Service limit states do not apply to posting without approval of the Chief Bridge Engineer.

27.2.3. Load Posting Notices

The Bridge Section sends posting notices to bridge owners and requests photographic evidence that the posting has been implemented. The correspondence requests that postings be implemented within 30 days or justification for not posting within this time frame.

Load posting notices for DOT&PF-owned structures are sent to the Region Director with copies to the Region Maintenance Chief, Maintenance Superintendent, Division Director MS&CVC, Chief MS&CVC, Administrative Supervisor of the Commercial Vehicle Customer Support Center MS&CVC, and the FHWA Alaska Division Structures Research Engineer.

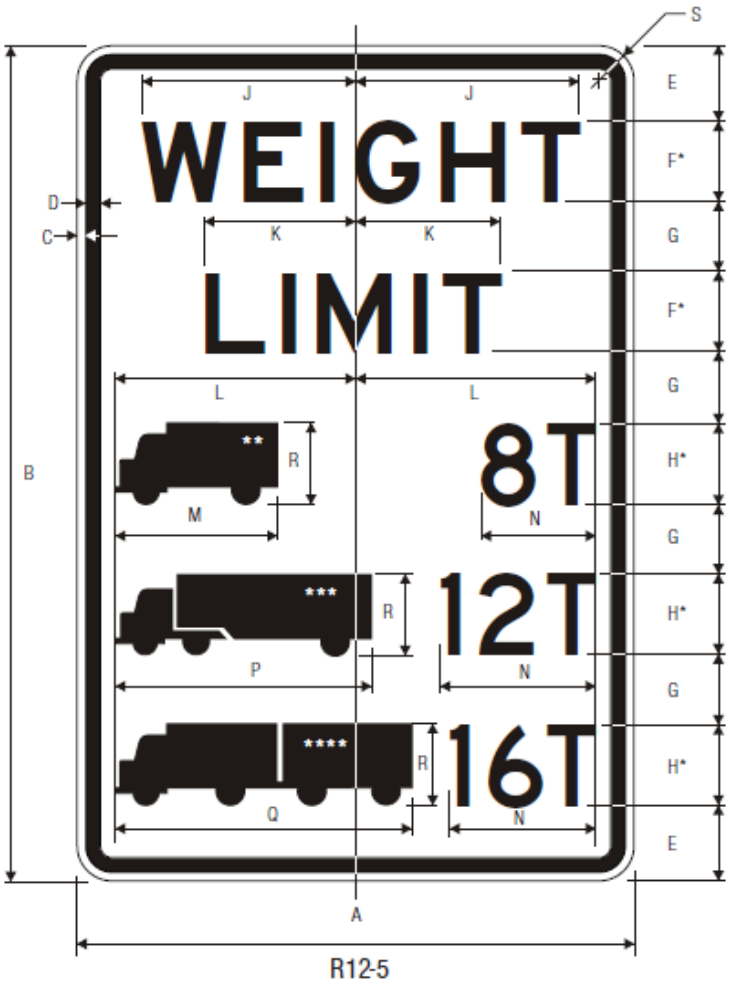
Load posting notices for other state agency-owned and local agency-owned structures are sent to the identified owner with a copy to the DOT&PF Region Director, Maintenance Chief, Maintenance Superintendent, Division Director MS&CVC, Chief MS&CVC, Administrative Supervisor of the Commercial Vehicle Customer Support Center MS&CVC, and the FHWA Alaska Division Structures Research Engineer.

Load posting notices sent to the owners are filed in the hard copy bridge folder, e-vault, and load rating files.

The Bridge Section maintains a suspense file mechanism to track and send bi-monthly follow-up correspondence to bridge owners notifying them of the need to load post the bridge.

27.2.4. Signing

Use only those signs approved for use in the *Alaska Sign Design Specifications* (*ASDS*) for posting. For simple understanding of load posting signs, where possible, post using gross weight limits only (example shown in Figure 27-2). The following figures duplicate the applicable signs from the *ASDS*.



R12-5

WEIGHT LIMIT

*Series 2000 Standard Alphabets.
**See page 6-4 for design
***See page 6-5 for design
****See page 6-6 for design

C

A	B	C	D	E	F	G	H	J	K	L	M
24	36	.375	.625	3.25	3.5 E	3	3.5 D	9.465	6.403	10.375	7
30	42	.5	.75	3.75	4.5 E	3	4.5 D	12.016	8.192	13.188	9
36	48	.625	.875	5	5 E	3.25	5 D	13.350	9.099	15	10
48	60	.75	1.25	6	6 E	4.5	6 D	16.02	10.918	19	12

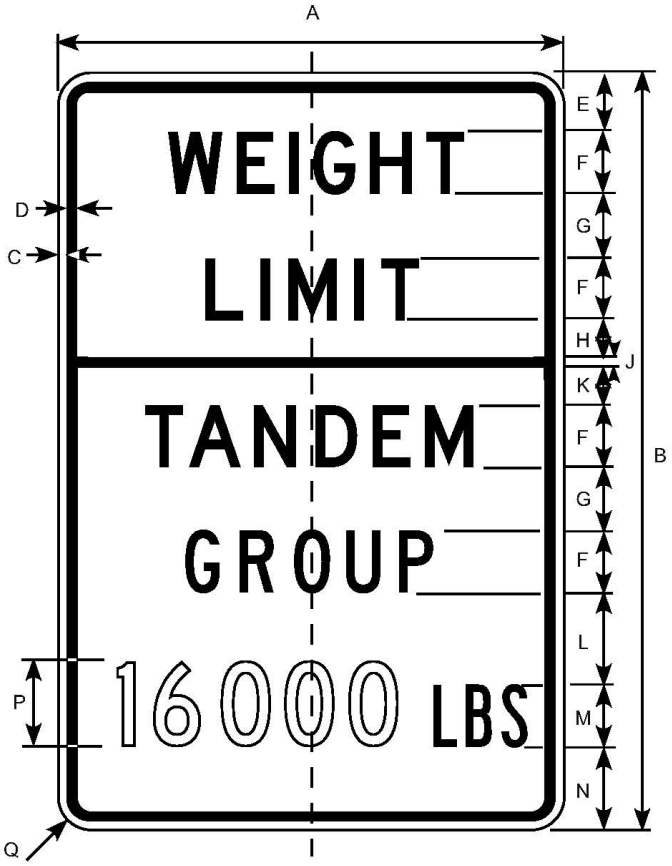
N	P	Q	R	S
VAR	11	12.813	3.5	1.5
VAR	13.438	16.438	4.5	1.875
VAR	15.438	18.375	5	2.25
VAR	19.688	22	6	3

COLORS: LEGEND – BLACK
BACKGROUND– WHITE (RETROREFLECTIVE)

1-162

Figure 27-2
ASDS Signs Example
(Page 1 of 6)

R12-100



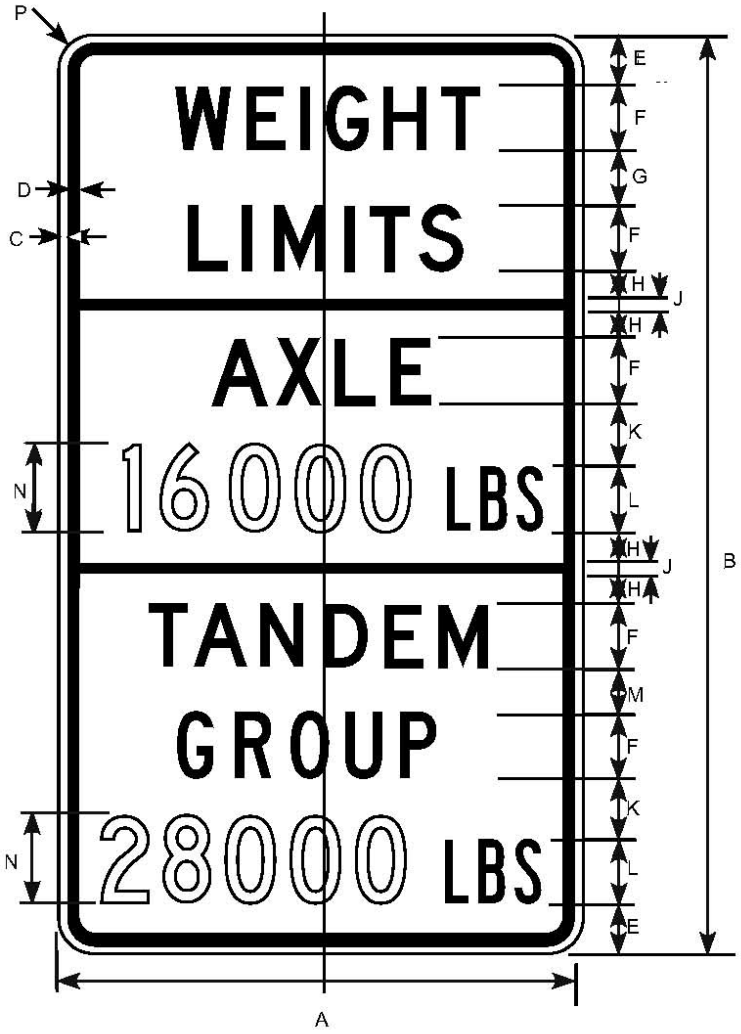
Border and Legend: Black
Background: White

Prior to the 2002 publication of this manual,
this sign was numbered R12-5A.

Road Class	Dimensions (inches)														
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q
Conv & Min	24	36	0.38	0.63	2.75	3C	3	1.69	0.63	1.69	4.13	3B	4.13	4C	1.5

Figure 27-2
ASDS Signs Example
(Page 2 of 6)

R12-101



Border and Legend: Black
Background: White

Prior to the 2002 publication of this manual, this sign was numbered R12-5B.

Road Class	Dimensions (inches)													
	A	B	C	D	E	F	G	H	J	K	L	M	N	P
Conv & Min	24	42	0.38	0.63	2.25	3C	2.50	1.25	0.63	2.88	3B	2	4C	1.5

Figure 27-2
ASDS Signs Example
(Page 3 of 6)

R12-2
AXLE WEIGHT LIMIT

*Reduce spacing 50%.

C	A	B	C	D	E	F	G	H	J	K	L
	24	30	.375	.625	3.25	4 D	2	2.5	5 D	6.875	9
	36	48	.625	.875	5.25	6 D	3.5	4.5	8 D	10.313	13.5

M	N	P	Q
9.5	6.313	10	1.5
14.25	9.438	15	2.25

COLORS: LEGEND — BLACK
BACKGROUND— WHITE (RETROREFLECTIVE)

1-158

Figure 27-2
ASDS Signs Example
(Page 4 of 6)

R12-1
WEIGHT LIMIT

*Optically space numerals about centerline.

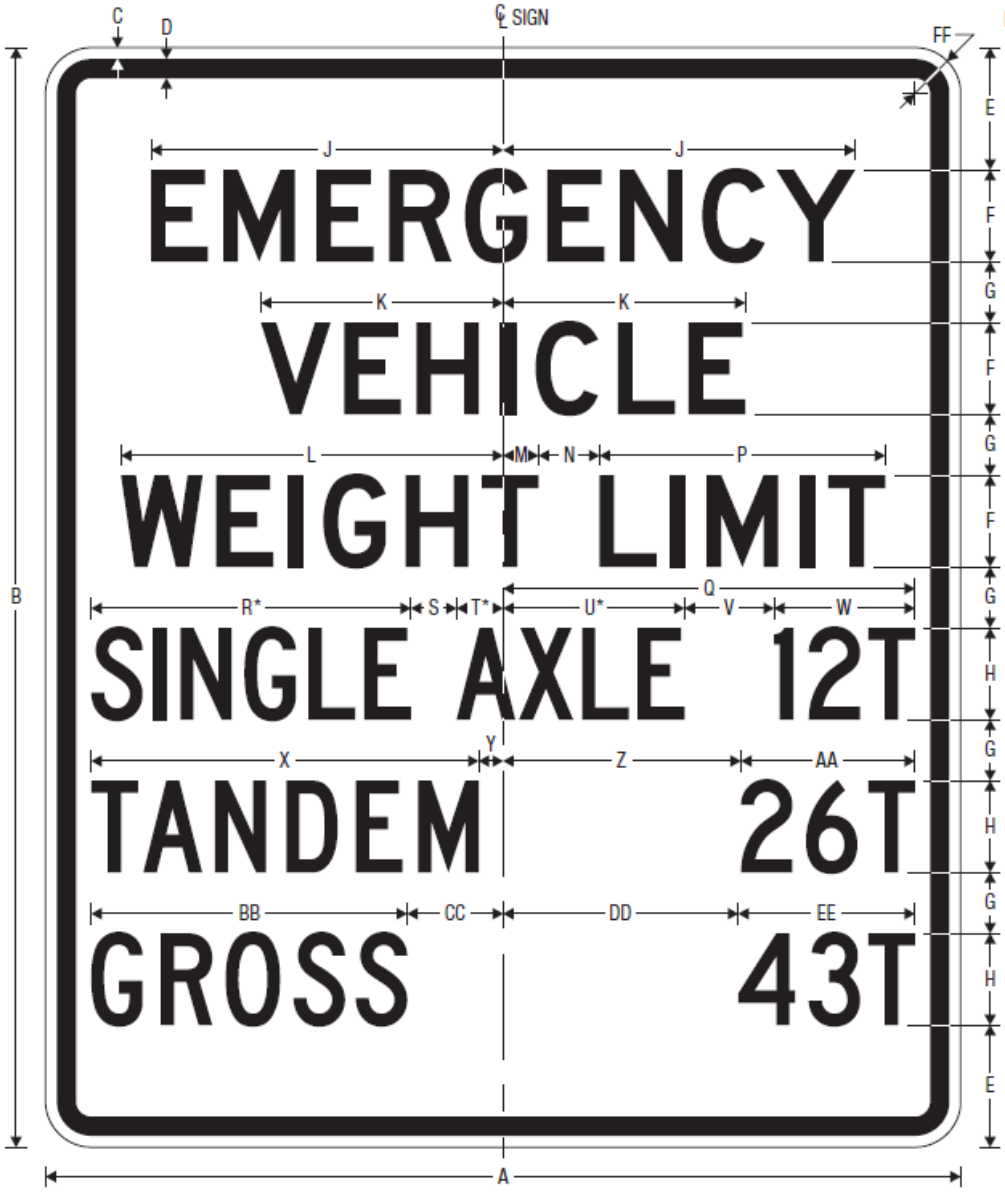
	A	B	C	D	E	F	G	H	J	K	L
C	24	30	.375	.625	3	4 D	1.75	2.125	5 E	5D	9
	36	48	.625	.875	4.75	6 D	3	3.75	8 E	8 D	13.5

M	N	P	Q
9.5	6.313	8.25	1.5
14.25	9.438	13.25	2.25

COLORS: LEGEND – BLACK
BACKGROUND– WHITE (RETROREFLECTIVE)

1-156

Figure 27-2
ASDS Signs Example
(Page 5 of 6)



R12-7

EMERGENCY VECHICLE WEIGHT LIMIT

* Reduce character spacing 30%.

A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q
30	36	0.375	0.625	4	3 D	2	3 C	11.542	7.939	12.525	1.163	2	9.363	13.5
48	60	0.75	1.25	6.875	5 D	3.75	4.5 C	19.237	13.232	20.833	1.979	3.25	15.605	20.833

R	S	T	U	V	W	X	Y	Z	AA	BB	CC	DD	EE	FF
10.477	1.5	1.523	5.944	VAR	VAR	12.695	0.805	VAR	VAR	10.354	3.146	VAR	VAR	1.5
15.715	2.5	2.618	8.583	VAR	VAR	19.043	1.790	VAR	VAR	15.531	5.302	VAR	VAR	3

COLORS: LEGEND, BORDER — BLACK
BACKGROUND — WHITE (RETROREFLECTIVE)

Figure 27-3
ASDS Signs Example
(Page 6 of 6)

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