



Evaluation of Load Ratings for Alaska Legal Loads Exempted by Federal Law

FINAL REPORT



Prepared by:
Modjeski and Masters, Inc.
Sylwia Stawska PhD, PE
Rachel Mertz, PE, SE
Thomas Murphy, PhD, PE, SE
Mechanicsburg, PA

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13. ABSTRACT (Maximum 200 words) This study evaluates the impact of Alaska's legal and routine permit traffic on bridges and proposes updated rating procedures. Unlike other states, Alaska does not impose a gross vehicle weight limit but regulates axle weights and spacings. To assess the force effects of this traffic, the study utilizes Alaska Weigh-in-Motion data. Influence line analysis was conducted on typical bridge types and configurations, comparing load effects from Alaska's traffic with AASHTO MBE legal rating trucks and specialized hauling vehicles. An Alaska-specific Live Load Model was developed, and a full reliability-based calibration was conducted to determine whether current AASHTO MBE procedures sufficiently capture the impact of Alaska's traffic conditions. Based on these findings, the study recommends updated live load factors and introduces a linear scale factor approach, which uses the ratio of the current AASHTO MBE live load factor to the recommended factor. This method simplifies the re-rating of Alaska's bridge inventory, ensuring consistency and efficiency.				
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METRIC (SI*) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know Symbol	Multiply By	To Find
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When You Know	Multiply	To Find
Symbol By		

LENGTH	
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LENGTH

in	inches	25.4	mm
ft	feet	0.3048	m
yd	yards	0.914	m
mi	Miles (statute)	1.61	km

mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	Miles (statute)	mi

AREA

AREA

in ²	square inches	645.2	millimeters squared	cm ²
ft ²	square feet	0.0929	meters squared	m ²
yd ²	square yards	0.836	meters squared	m ²
mi ²	square miles	2.59	kilometers squared	
ac	acres	0.4046	hectares	ha

mm ²	millimeters squared	0.0016	square inches	in ²
m ²	meters squared	10.764	square feet	ft ²
km ²	kilometers squared	0.39	square	miles
	mi ² ha	hectares (10,000 m ²)		
	2.471	acres	ac	

MASS
(weight)

MASS
 (weight)

oz	Ounces (avdp)	28.35	grams	g
lb	Pounds (avdp)	0.454	kilograms	kg
T	Short tons (2000 lb)	0.907	megagrams	mg

g	grams	0.0353	oz
kg	kilograms	2.205	lb
mg	megagrams (1000 kg)	1.103	short tons

VOLUME

VOLUME

fl oz	fluid ounces (US)	29.57	milliliters	mL
gal	Gallons (liq)	3.785	liters	
	liters ft ³	cubic feet	0.0283	
	meters cubed	m ³		
yd ³	cubic yards	0.765	meters cubed	m ³

Note: Volumes greater than 1000 L shall be shown in m³

mL	milliliters	0.034	fluid ounces (US)	fl
oz	liters	0.264	Gallons (liq)	
m ³	gal			
m ³	meters cubed	35.315	cubic feet	ft ³
	meters cubed	1.308	cubic yards	

Note: Volumes greater than 1000 L shall be shown in m³

TEMPERATURE
(exact)

yd ³	
-----------------	--

°F	Fahrenheit temperature	5/9 (°F-32)	Celsius temperature	°C
----	------------------------	-------------	---------------------	----

TEMPERATURE

ILLUMINATION

(exact)

fc	Foot-candles	10.76	lux	lx
fl	foot-lamberts cd/cm ²	3.426	candela/m ²	

°C	Celsius temperature	9/5 °C+32	Fahrenheit	°F
temperature				
ILLUMINATION				

FORCE and PRESSURE or STRESS

lx	lux	0.0929	foot-candles	fc
cd/cm	candela/m ²	0.2919	foot-lamberts	fl

lbf	pound-force	4.45	newtons	N
psi	pound-force per	6.89	kilopascals	kPa
square inch				

2
FORCE and PRESSURE or STRESS

These factors conform to the requirement of FHWA Order 5190.1A *SI is the symbol for the International System of Measurements

N	newtons	0.225	pound-force	lbf
kilopascals	0.145	pound-force per		
	psi	square inch		

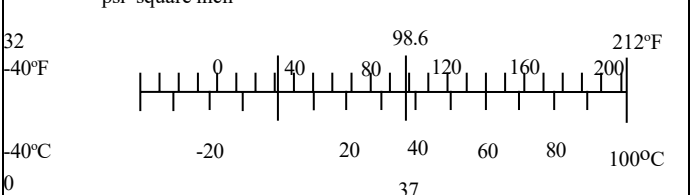


Table of Contents

List of Figures	v
List of Tables	vii
Executive Summary	ix
Chapter 1: Comprehensive Review of Federal and Alaska Statutes.....	1
Chapter 2: Alaska Weigh-in-Motion Data.....	3
2.1 WIM Locations and Data Attributes.....	3
2.2 WIM Data Selection	5
2.3 WIM Legal Filters	9
Chapter 3: Alaska Legal and Routine Permit Traffic	11
Chapter 4: Alaska Bridge Inventory	14
Chapter 5: Influence Line Analysis	16
5.1 WIM Load Effects.....	17
5.2 AASHTO MBE Legal Load Effects	17
5.3 AASHTO Design Load Effects	18
Chapter 6: Reliability-Based Calibration.....	20
6.1 Alaska Legal Live Load Model.....	21
6.1.1 Development of Statistical Parameters.....	21
6.1.2 Selection of Statistical Parameters	23
6.2 Dead Load Model	26
6.3 Resistance Model.....	28
6.4 Calibration Approach.....	28
6.5 Calibration Results.....	29
6.5.1 Calibration of Live Load Factor	29
6.5.2 Calculation of Reliability Index	31
Chapter 7: Ore Truck Traffic in Alaska.....	34
7.1 Ore trucks in WIM data.....	34
7.2 Ore Traffic Calibration	36
7.3 Long Combination Vehicle Calibration.....	38
Chapter 8: Deterministic Analysis	41
8.1 Alaska Traffic Classification	41

8.1.1 Typical Trucks.....	42
8.1.2 Alaska Combination and Long Combination Vehicles	44
8.2 Force Effects Ratios	45
8.2.1 Legal Traffic	47
8.2.2 Routine Permit Traffic	48
8.2.3. Design Trucks.....	50
Chapter 9: Bridge Rating Recommendations	51
9.1 Load and Resistance Factor Rating.....	51
9.2 Load Factor Rating.....	52
9.3 Allowable Stress Rating.....	52
Chapter 10: Bridge Rating Examples	56
10.1 Example 1 – LRFR for ADTT =1,000	57
10.2 Example 2 – LRFR for ADTT =5,000	59
10.3 Example 3 – LFR	61
10.4 Example 4 – ASR.....	63
Summary of the Study	65
References.....	67
Appendices.....	68
Appendix A: Excerpts from CFR Title 23, Part 658	A-1
Appendix B: Excerpts from Alaska Administrative Code Title 17	B-1
Appendix C: Characteristics of Alaska WIM Data Classification Scheme	C-1
Appendix D: WIM Quality Control Results by WIM site and year.	D-1
Appendix E: Alaska Long Combination Vehicle Routes.....	E-1
Appendix F: Gross Vehicle Weight Statistics	F-1
Appendix G: WIM Live Load Force Effects.....	G-1
Appendix H: AASHTO MBE Legal Rating Trucks Configurations.....	H-1
Appendix I: AASHTO MBE Specialized Hauling Vehicles Configurations	I-1
Appendix J: Controlling Load Cases for AASHTO MBE Legal Rating Trucks	J-1
Appendix K: AASHTO HL-93 Design Load Configurations.....	K-1
Appendix L: AASHTO HS-20 Design Load Configurations	L-1
Appendix M: Controlling Load Effects for AASHTO Design Trucks	M-1

Appendix N: Characteristics of Alaska Trucks with more than 7 axles	N-1
Appendix O: Alaska Typical Truck Configurations	O-1
Appendix P: Alaska AASHTO MBE Legal Configurations	P-1
Appendix Q: Alaska Combination and Long Combination Vehicle Configurations ...	Q-1

List of Figures

Figure 2-1: Alaska WIM Site Locations.....	4
Figure 2-2: FHWA Vehicle Classification scheme	5
Figure 3-1: Distribution of upper tail (20% largest) GVW and length for legal, routine permit, and combination of legal and routine permit trucks in Alaska for “gln” WIM site.....	12
Figure 3-2: Upper tail (20% heaviest trucks) histogram of number of axles for legal, legal and routine permit, and routine permit trucks for “gln” WIM site.....	12
Figure 3-3: Percentage of trucks for all WIM data and upper tail for GVW ranges	13
Figure 4-1: Maximum span length distribution of Alaska bridges	14
Figure 4-2: Material type distribution of Alaska bridges.....	15
Figure 4-3: Average Daily Truck Traffic distribution of Alaska bridges	15
Figure 5-1: Configuration of bridge structure types (a) Simple Span Structures, (b) 2-Span Cont. Structures with Equal Spans, and (c) 3-Span Structures with Unequal Spans.	17
Figure 5-2: Simple Span Moment for short (20 feet), medium (100 feet), and long (200 feet) bridges.....	17
Figure 5-3: Ratio of maximum Alaska WIM force effect to HL-93 loading at the inventory level.	19
Figure 5-4: Ratio of maximum Alaska WIM force effect to HS-20 loading at the inventory level.	19
Figure 6-1: Maximum WIM, and Extrapolated Bias Factors for Alaska Traffic.	23
Figure 6-2: Extrapolated bias for Alaska Legal WIM traffic and AASHTO LRT.....	23
Figure 6-3: Bias Factor for AASHTO MBE Legal Rating Truck (LRT).	25
Figure 6-4: Bias Factor for AASHTO MBE Specialized Hauling Vehicles (SHV).....	25
Figure 6-5: Dead Load to Live Load Ratios (D/L) for Steel and Concrete Bridges.....	27
Figure 6-6: Probabilistic Calibration Approach.....	29
Figure 6-7: Calibrated Live Load Factors for AASHTO MBE LRT, and ADTT = 1,000	30
Figure 6-8: Calibrated Live Load Factors for AASHTO MBE LRT, and ADTT = 5,000	30
Figure 6-9: Calibrated Live Load Factors for AASHTO MBE SHV, and ADTT = 1,000	31
Figure 6-10: Calibrated Live Load Factors for AASHTO MBE SHV, and ADTT = 5,000	31
Figure 6-11: Reliability index for AASHTO MBE LRT, and ADTT = 1,000	32
Figure 6-12: Reliability index for AASHTO MBE LRT, and ADTT = 5,000	32

Figure 6-13: Reliability Index for AASHTO MBE SHV, and ADTT = 1,000	33
Figure 6-14: Reliability Index for AASHTO MBE SHV, and ADTT = 5,000	33
Figure 7-1: Ore truck configuration.....	34
Figure 7-2: Average Daily Truck Traffic at Fox and Tok WIM sites for the years 2020-2024. ..	35
Figure 7-3: Bias factor for the Ore and WIM trucks for moment.....	37
Figure 7-4: Bias factor for the Ore and WIM trucks for shear.	37
Figure 7-5: Calibrated Live Load Factors for Ore trucks	38
Figure 7-6: Reliability index for Ore trucks.	38
Figure 7-7: Bias factor for the LCV and WIM trucks for ADTT of 5,000.....	39
Figure 7-8: Coefficient of variation (COV) for the LCV and WIM trucks for ADTT of 5,000...	39
Figure 7-9: Reliability index for Long Combination Vehicles, and live load factor of 1.65.....	40
Figure 7-10: Reliability index for Long Combination Vehicles, and live load factor of 1.75.....	40
Figure 8-1: Wheelbase vs. GVW of the representative Legal and 125% Legal Alaska trucks. ...	42
Figure 9-1: Alaska timber bridge characteristics.....	53

List of Tables

Table 2-1: Available Alaska WIM Data	4
Table 2-2: Number of Available WIM Records per year and WIM site	6
Table 2-3: Number of days with WIM Records per year and WIM site	6
Table 2-4: Computed ADTT per year and WIM site.....	6
Table 2-5: Quality Control Criteria.....	7
Table 2-6: Quality Control for all WIM data.....	8
Table 2-7: Selected Alaska WIM sites and years.	8
Table 2-8: Alaska Legal Load Filters.	10
Table 2-9: Summary of Filtered WIM data	10
Table 3-1: GVW statistics for Legal and Routine Permit traffic in Alaska.	13
Table 6-1: Weighted Average Bias Factor for Simple Span Moment Case (M11).....	24
Table 6-2: Dead load statistical parameters and load factors.	26
Table 6-3: Statistical Parameters of Resistance	28
Table 7-1: Fox and Tok WIM statistics for trucks with GVW greater than 150 kips.	35
Table 8-1: Typical Truck Configurations maximized per Alaska statutes.	43
Table 8-2: AASHTO MBE Legal Truck Configurations Maximized per Alaska statutes.	43
Table 8-3: Combination and Long Combination Vehicle Configurations Maximized per Alaska statutes.....	45
Table 8-4: Force Effect Ratios for Alaska Legal Typical Vehicles to LRTs with LLF = 1.60	47
Table 8-5: Force Effect Ratios for Alaska Legal LCVs to LRTs with LLF = 1.75.....	48
Table 8-6: Force Effect Ratios for Alaska Routine Permit Trucks to LRTs with LLF = 1.60	48
Table 8-7: Force Effect Ratios for Alaska Legal Vehicles compared to Inventory Design Trucks.	50
Table 9-1: Recommended Live Load and Scale Factors for LRFR at Operating Level.....	51
Table 9-2: Recommended Live Load and Scale Factors for LFR at Operating Level.	52
Table 9-3: Recommended Scale Factors for ASR.	54
Table 9-4: LFR calculations for sample timber bridges.	55
Table 9-5: ASR calculations for sample timber bridges.	55
Table 9-6: Comparison of ASR and LFR Rating Factors with variable scale factors.	55

Table 10-1: LRFR Scale Factor at Operating Level for ADTT = 1,000.....	57
Table 10-2: Scale Factor Example LRFR for ADTT = 1,000	58
Table 10-3: LRFR Scale Factor at Operating Level for ADTT = 5,000.....	59
Table 10-4: Scale Factor Example LRFR for ADTT = 5,000	60
Table 10-5: LFR Scale Factors at Operating Level	61
Table 10-6: Scale Factor Example for LFR.....	62
Table 10-7: Scale Factor for ASR at Operating Level.....	63
Table 10-8: Scale Factor Example for ASR	64

Executive Summary

During the FHWA's annual assessment of Alaska's program, Alaska was found to be noncompliant for Metric 13 because current procedures did not evaluate all possible Alaska-specific legal loads. Modjeski and Masters, Inc. (M&M) was tasked by the Alaska Department of Transportation and Public Facilities (DOT&PF) to review Alaska legal and routine permit regulations, assess the impact of legal live loads on bridges, and provide guidance on bridge rating procedures. Alaska regulations restrict axle weights and spacings; however, Alaska is exempt from the federal regulation that imposes an 80,000-pound gross vehicle weight limit on interstate loads. Thus, heavier trucks can legally travel over Alaska's bridges. The objective of this study was to develop an Alaska Legal Live Load Model that envelops Alaska legal trucks and develop new scale factors for the existing legal rating vehicles at the operating level defined in the AASHTO Manual for Bridge Evaluation (AASHTO MBE) to encompass Alaska's legal traffic conditions.

This study utilized Alaska Weigh-in-Motion (WIM) data to evaluate the effects of legal traffic on bridges. A comprehensive literature review of Alaska law formed the basis for identifying and capturing legal and state routine permits within the WIM data. These legal WIM trucks were analyzed using influence line analysis on typical bridge types and configurations. The resulting load effects were then compared to those of the AASHTO MBE legal rating trucks, including routine commercial traffic and specialized hauling vehicles.

An Alaska Live Load Model was developed and utilized in a reliability-based calibration to determine whether the current AASHTO MBE legal load rating procedures adequately envelop the allowable legal loads in Alaska. The study identified appropriate live load factors that meet the minimum reliability index specified in the AASHTO MBE and recommended new live load and scale factors at the operating level for use in Alaska's bridge rating procedures.

This report documents the findings and recommendations of the study. It includes detailed information on the project background, scope, methodology, and data analysis, and provides rating examples to illustrate the use of calibrated live load factors and scale factors within the rating procedures.

Chapter 1: Comprehensive Review of Federal and Alaska Statutes

In CY2022 (PY2023), FHWA performed an annual In-Depth Assessment (InD-AL) of Alaska's program for Metric 13, Inspection Procedures – Load Rating, in accordance with the National Bridge Inspection Program (NBIP), and found Alaska noncompliant because current Alaska load rating procedures do not encompass all possible Alaska-specific legal loads. Alaska regulations do not impose a limit on Gross Vehicle Weight (GVW) but do restrict axle weights and spacings. Thus, trucks with a GVW greater than 80 kips can legally operate on the system. The first step of this study was to review federal and state regulations that pertain to truck size and weight restrictions and determine what is legal in Alaska. These regulations provide a basis for the Alaska Legal Live Load model and proposed load rating procedure that encompasses all legal trucks.

Federal and Alaska laws impose restrictions on the width, length, and weight of trucks. A review of the Code of Federal Rules (CFR) Title 23, Part 658 - *Truck Size and Weight, Route Designations – Length, Width and Weight Limitations* and Alaska Administrative Code (AAC) Title 17 – *Transportation and Public Facilities* was conducted to determine legal and routine permit weight and length limits applicable in Alaska. The findings from this review are summarized below. **Appendix A** of this document includes excerpts from the relevant CFR sections, and **Appendix B** provides excerpts from the AAC.

CFR § 658.13 states that length limitations will not be imposed of less than 48 feet on a semitrailer in a truck tractor-semitrailer, 28 feet on any semitrailer or trailer operating in a truck tractor-semitrailer-trailer combination, and 28.5 feet on any semitrailer or trailer operating in a truck tractor-semitrailer-trailer combination with total length less than 65 feet. Regarding weight, **CFR § 658.17** specifies that vehicles operating on the National System of Interstate Highways must not exceed the following limits: (1) a maximum gross vehicle weight of 80,000 lbs, (2) a maximum single axle load of 20,000 lbs, (3) a maximum tandem axle load of 34,000 lbs, and (4) gross weight on two or more consecutive axles as determined by the Federal Bridge Formula (FBF). Additionally, vehicles that utilize auxiliary power or idle reduction technology are allowed an additional 400 lbs in gross weight. However, Alaska DOT&PF regulations do not impose a limit on GVW; thus, vehicles traveling in Alaska are exempt from CFR (1) is exempted. CFR Appendix C gives state-specific allowances, and in Alaska, allows truck tractors with two trailing units to operate without a permit if their total cargo carrying unit length does not exceed 95 feet on the interstate system in Alaska. Also, on selected Alaska roads, the length of cargo-carrying units can be up to 110 feet.

Alaska Administrative Code (AAC) Title 17, Chapter 25 *Operations, Wheeled Vehicles* provides specific requirements on the length and weight of legal trucks. A summary of pertinent regulations is as follows:

According to **AAC 25.012**, the cargo-carrying length of a semitrailer or trailer may not exceed 53 feet. Cargo carrying is any portion of a commercial motor vehicle combination (other than a truck tractor) used for carrying cargo, including a trailer, semitrailer, or the cargo-carrying section of a single-unit truck. Besides, the overall length of a truck and one cargo-carrying vehicle or a truck tractor and one or two cargo-carrying vehicles may not exceed 75 feet. However, a combination of a truck tractor and one cargo-carrying vehicle is not subject to an overall length limit on the Interstate Highway System.

AAC 25.013 sets specific weight limits on Alaska legal trucks. A single axle has a maximum weight limit of 20,000 lbs, while tandem axles are limited to 38,000 lbs with a minimum spacing of 3'-6". Tridem axles are subject to varying limits based on spacing: 42,000 lbs with a minimum spacing of 3'-6", 43,500 lbs with a minimum spacing of 5'-0", and 45,000 lbs with a minimum spacing of 6'-0". Quad axles are restricted to a maximum of 50,000 lbs. The FBF applies to vehicles with lift axles, and trucks without lift axles are allowed an additional 3,000 lbs to the applicable limit. Alaska does not impose a specific limit on GVW; instead, the gross weight is determined by axle group limits, the FBF, and allowable vehicle configurations. Additionally, vehicles equipped with an auxiliary power unit or idle reduction technology are permitted to carry an extra 550 lbs in power unit axle weights.

AAC 25.014 specifies allowable lengths for a Long Combination Vehicle (LCV) on designated routes in Alaska. The following limits apply to LCVs: (a) a maximum cargo-carrying length of 95 feet, measured from the front of the first cargo-carrying vehicle to the rear of the last, if individual trailers or semi-trailers do not exceed 48 feet, (b) an overall length of 90 feet for a truck with one cargo-carrying vehicle, (c) an overall length of 95 feet for a truck and one cargo-carrying vehicle, a truck tractor and one cargo-carrying vehicle, or a truck tractor and two cargo-carrying vehicles, and (d) an overall length of 120 feet for a truck tractor with a triple cargo-carrying vehicle combination when other requirements are met. One or more of these limits (a-d) are assigned to select routes.

AAC 25.320 outlines regulations for oversized and overweight vehicles, restricting movement authorization for loads exceeding 125 percent of the legal weight limits.

AAC 25.335 specifies that from October 1 through April 30 of each year, an extra allowance of 1,500 lbs is granted for snow and ice accumulation, given the presence of evidence for such build-up to the overall weight.

Chapter 2: Alaska Weigh-in-Motion Data

The objective of this study was to develop a bridge rating procedure that encompasses Alaska legal and state routine permit traffic. WIM data was used to assess the traffic-induced load effects of Alaska-specific trucks. WIM data offers detailed information on vehicle configurations, weights, traffic volume, composition, and frequency. This study followed the AASHTO Load and Resistance Factor (LRFD) probabilistic approach (NCHRP 368) that involved the development of an Alaska Legal Live Load Model, selection of the notional rating trucks, and calibration of live load factors that ensure consistent safety for Alaska's bridges. The WIM-based reliability approach offers comprehensive analysis consistent with AASHTO MBE provisions.

2.1 WIM Locations and Data Attributes

The DOT&PF has nine active WIM sites across the state. **Figure 2-1** presents a map with the numbered WIM sites with names indicated in dark blue labels. WIM data for the years 2015 to 2023 was provided by Drakewell, DOT&PF's WIM vendor. Notably, the Skagway-Klondike Highway WIM site has no available records and was not used as part of this study. Overall, there are eight functional WIM sites with over 16 million total truck records from the requested timeframe. **Table 2-1** lists all WIM sites, including their assigned numbers, abbreviated names, descriptions of the routes where the WIM sensors are located, with the number of available WIM records.

The WIM data contains detailed information about the traffic, including site location, specific date and time (year, month, day, hour, minute, and second), lane occupied, vehicle speed, GVW, individual axle weights and spacings, and vehicle class. The Federal Highway Administration (FHWA) provides a classification scheme to categorize vehicles in the traffic flow. **Figure 2-2** illustrates the FHWA vehicle classes, where Classes 1-3 are passenger cars and motorcycles, Class 4 consists of buses, and Classes 5-13 consists of various types of trucks, including single-unit, single-trailer, and multi-trailer trucks. The Alaska WIM data includes Vehicle Classes 1-16, with Classes 1-13 aligning with the FHWA scheme. Alaska Class 14 represents vehicles with unusual configurations that do not fit FHWA's classification scheme. Class 15 includes pickups and vans with trailers, and Class 16 covers light vehicles with rigid trailers. **Appendix C** provides details on Alaska vehicle class distributions, as well as GVW, and length evaluation for different WIM sites for Vehicle Classes 14, 15, and 16. Based on Alaska-specific classification, only Vehicle Class 14 will be considered in the analysis, as Classes 15 and 16 are light trucks that do not contribute to the development of the Alaska Legal Live Load Model.

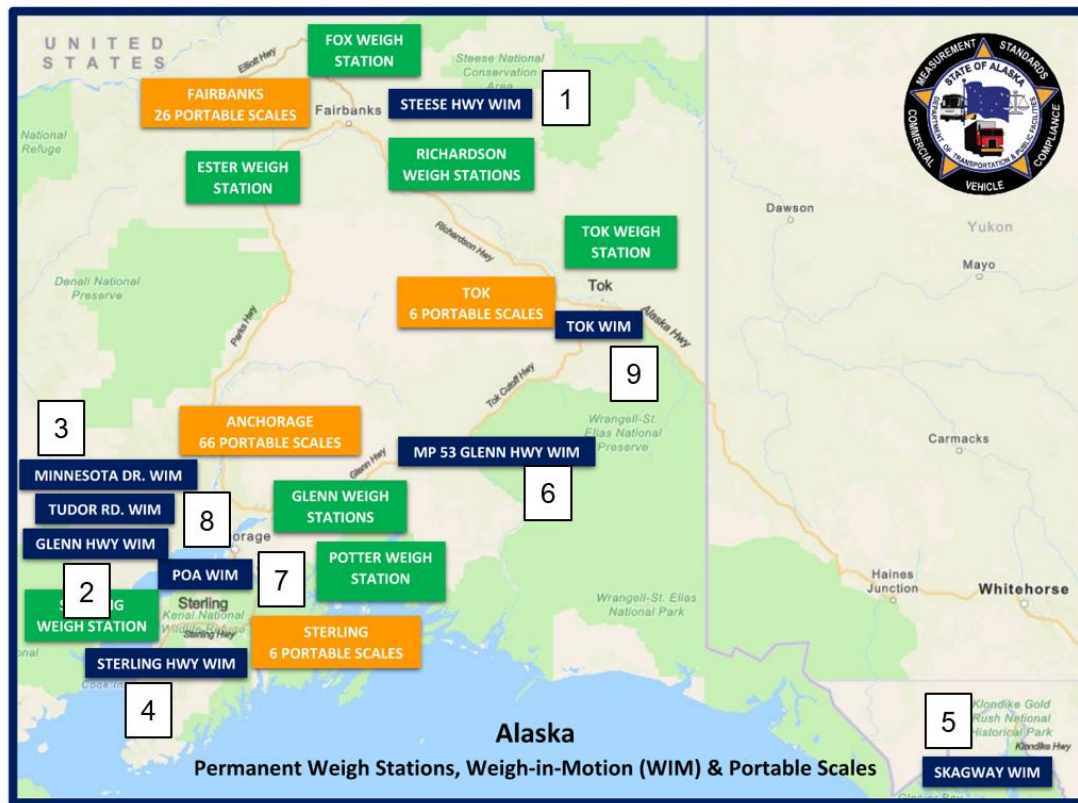


Figure 2-1: Alaska WIM Site Locations

Table 2-1: Available Alaska WIM Data

WIM ID	WIM Site	WIM Site Description	Total Number of Available WIM Records (2015-2023)
1	fox	Steese Highway (FOX)	1,641,741
2	gln	Glenn Highway (Scalehouse)	4,164,167
3	min	Minnesota Drive south of International Airport Road	1,690,478
4	ste	Sterling Hwy Btwn Lake Terrace Dr and Secret Rd	2,963,559
5	skg	Skagway - Klondike Highway	-
6	plm	Glenn Highway at MP 53	1,318,870
7	poa	Ocean Dock (Port of Anchorage)	2,521,701
8	tds	Tudor Road Btwn Patterson St and Kingston Rd	1,192,709
9	tok	Alaska Hwy at MP 1310	521,274
Total:			16,014,499

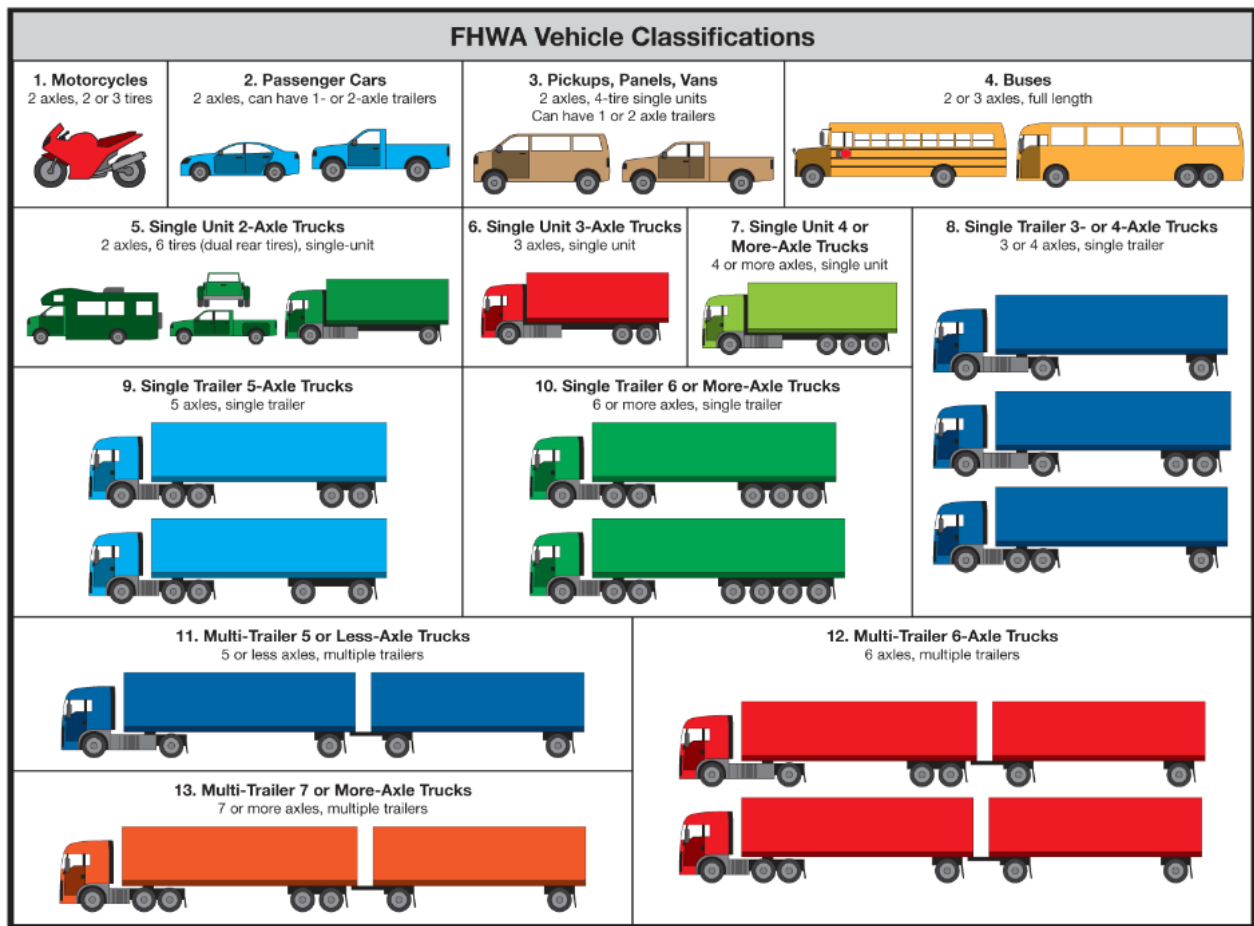


Figure 2-2: FHWA Vehicle Classification scheme

2.2 WIM Data Selection

WIM provides extensive truck traffic data, which requires screening to ensure only reliable data is used. In this study, WIM data underwent an initial screening procedure, followed by Quality Control (QC) filtering. First, the WIM data was grouped by WIM site and year. These smaller data sets were then checked for the number of records at each WIM site and year (**Table 2-2**), and the number of available days with WIM records (**Table 2-3**). Based on this information, the Average Daily Truck Traffic (ADTT) was computed (**Table 2-4**). This initial screening process provided a preliminary consistency check, ensuring that selected WIM data was recorded over an entire year(s) and was consistent from year to year.

Table 2-2: Number of Available WIM Records per year and WIM site

Number of Records											
WIM ID	WIM Site	2015	2016	2017	2018	2019	2020	2021	2022	2023	Total
1	fox	205,289	185,033	187,702	204,949	192,523	172,588	174,152	170,241	149,264	1,641,741
2	gln	-	-	-	-	-	1,329,662	1,670,334	262,998	901,173	4,164,167
3	min	-	-	-	-	-	310,785	441,531	472,360	465,802	1,690,478
4	ste	52,154	335,668	343,286	365,268	365,548	311,870	385,424	394,532	409,809	2,963,559
6	plm	47,113	201,590	143,443	6,842	175,969	158,924	188,763	192,912	203,314	1,318,870
7	poa	156,269	366,337	348,740	355,601	129	246,831	354,392	363,494	329,908	2,521,701
8	tds	-	-	-	-	-	239,128	348,172	316,989	288,420	1,192,709
9	tok	15,412	69,926	51,393	69,127	73,514	44,414	49,267	62,854	85,367	521,274

Table 2-3: Number of days with WIM Records per year and WIM site

Number of Days with WIM Records											
WIM ID	WIM Site	2015	2016	2017	2018	2019	2020	2021	2022	2023	
1	fox	365	357	365	365	361	355	365	361	291	
2	gln	0	0	0	0	0	366	241	98	288	
3	min	0	0	0	0	0	255	365	358	365	
4	ste	61	362	358	365	358	257	365	365	365	
6	plm	121	366	302	30	361	269	365	365	365	
7	poa	121	357	365	365	1	257	365	365	342	
8	tds	0	0	0	0	0	257	365	355	324	
9	tok	121	366	266	365	365	366	365	365	365	

Table 2-4: Computed ADTT per year and WIM site

Computed Average Daily Truck Traffic											
WIM ID	WIM Site	2015	2016	2017	2018	2019	2020	2021	2022	2023	
1	fox	562	518	514	562	533	486	477	472	513	
2	gln	-	-	-	-	-	3,633	6,931	2,684	3,129	
3	min	-	-	-	-	-	1,219	1,210	1,319	1,276	
4	ste	855	927	959	1,001	1,021	1,214	1,056	1,081	1,123	
6	plm	389	551	475	228	487	591	517	529	557	
7	poa	1,291	1,026	955	974	129	960	971	996	965	
8	tds	-	-	-	-	-	930	954	893	890	
9	tok	127	191	193	189	201	121	135	172	234	

WIM data was then filtered through a QC procedure aligned with previous calibration studies, such as NCHRP 12-83. The QC procedure includes fifteen distinct criteria outlined in **Table 2-5**. The QC filtering checks for invalid dates, zero records, and logical limits on weight and spacing. Criterion 10 removes all vehicles with a GVW of less than 12,000 lbs, excluding light or empty trucks not needed for the analysis. Since the primary goal of the WIM data evaluation was to determine the maximum expected load, lighter vehicles are not essential for the analysis. Additionally, Criterion 11 was initially set to filter out axle spacings less than 3.5 feet per the

statutes. However, a significant percentage of truck axle spacings in the Alaska WIM data were recorded as 3.2 feet. To avoid discarding this portion of the traffic, this criterion was adjusted to axle spacings less than 3.2 feet.

Table 2-5: Quality Control Criteria

No.	Quality Control Criteria
1	Invalid month
2	Invalid day
3	Records with zero Gross Vehicle Weight
4	Records with zero axle weight
5	Records with zero axle spacing
6	Axle weight less than 2 kips
7	Axle weight greater than 45 kips
8	Steering Axle weight greater than 35 kips
9	GVW inconsistent with the sum of axle weights +/- 10%
10	GVW less than 12 kips
11	Axle spacing less than 3.2 feet
12	Axle spacing greater than 50 feet
13	First axle spacing less than 6 feet
14	Total length less than 7 feet
15	Total length more than 120 feet

The QC criteria were applied to all WIM sites and years, as well as to the combined WIM data across all years for each WIM site. The QC summary shown in **Table 2-6** provides the percentage of records that did not meet the criteria. The QC analysis revealed that the "gln" WIM site contained a significant number of empty records. Other WIM sites showed a large percentage of records with axle weights less than 2 kips and GVWs below 12 kips. These trucks were discarded as they do not impact the legal live load envelope. Additionally, some WIM truck records indicated axle spacings less than 3.2 feet. As a result, approximately 57% of the trucks were excluded from the analysis, primarily because they were light or empty vehicles. The WIM prescreening and QC analysis identified a suitable and reliable dataset to be used for further analysis. **Table 2-7** presents the filtered WIM data selected to capture Alaska legal and routine permit traffic. Annual WIM data for eight WIM sites, with varying ADTT and traffic characteristics, provide a sufficient data set to evaluate traffic-induced load effects on Alaska bridges. The years were selected to capture the most recent data, thus, only 2022 or 2023 WIM data were selected for further evaluation. **Appendix D** includes tables summarizing the QC filtering results for individual WIM sites and years.

Table 2-6: Quality Control for all WIM data

WIM ID	WIM Site	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Total Number of Records Before Filtering	Remaining Number of Records After QC Filtering
		Invalid Month	Invalid Day	Zero GVW	Zero Axle Weight	Zero Spacing	Axle Weight < 2kip	Axle Weight > 45kip	1st Axle Weight > 35kip	GVW +/- 10%	GVW < 12 kips	Axle Spacing < 3.2 ft	Axle Spacing > 50 ft	1st Axle Spacing < 6 ft	Total length < 7 ft	Total length > 120 ft	Any		
1	fox	0%	0%	0%	0%	0%	11%	0%	0%	0%	50%	5%	0%	1%	0%	0%	56%	1,641,741	726,757
2	gln	0%	0%	76%	76%	0%	4%	0%	0%	0%	84%	10%	0%	0%	0%	0%	85%	4,164,167	621,854
3	min	0%	0%	0%	0%	0%	7%	0%	0%	0%	49%	0%	0%	1%	1%	0%	51%	1,690,478	831,729
4	ste	0%	0%	0%	0%	0%	20%	0%	0%	0%	58%	3%	0%	0%	0%	0%	63%	2,963,559	1,097,659
6	plm	0%	0%	0%	0%	0%	27%	0%	0%	0%	50%	0%	0%	2%	1%	0%	58%	1,318,870	554,628
7	poa	0%	0%	0%	0%	0%	4%	0%	0%	0%	10%	0%	0%	0%	0%	0%	12%	2,521,701	2,228,402
8	tds	0%	0%	0%	0%	0%	13%	0%	0%	0%	50%	0%	0%	2%	0%	0%	53%	1,192,709	565,500
9	tok	0%	0%	0%	0%	0%	13%	0%	0%	0%	37%	13%	0%	1%	0%	0%	53%	521,274	247,330
Total																	57%	16,014,499	6,873,859

Table 2-7: Selected Alaska WIM sites and years.

WIM ID	WIM Site	Year	Number of Remaining WIM Records after Filtering
1	fox	2022	66,991
2	gln	2023	128,675
3	min	2023	229,166
4	ste	2023	135,851
6	plm	2023	63,275
7	poa	2022	336,951
8	tds	2023	137,403
9	tok	2023	29,342

2.3 WIM Legal Filters

After completing the QC checks and selecting the WIM data, the next step was to identify the Alaska legal trucks in the WIM data. Based on a comprehensive review of the Alaska Statutes and discussions with DOT&PF, including the Measurement Standards and Commercial Vehicle Compliance (MS/CVC) Section, a set of legal weight and length filters was developed to accurately capture Alaska legal traffic. **Table 2-8** presents a list of fifteen legal filters: eight of them address weight limits and the remaining seven focus on length limits. Each WIM truck record was checked against the developed filters, and if any of the criteria were violated, the vehicle was flagged as "above the legal limit."

The weight filters (1-8) include restrictions on individual axle weights, axle groups (tandem, tridem, and quad), and the FBF with an additional 4,500 lbs to account for Alaska-specific allowances, including 3,000 lbs for trucks without lift axles and 1,500 lbs for snow/ice buildup tolerance. As the WIM scales do not recognize vehicle lift axles, and to account for the additional allowance for winter conditions, a maximized FBF allowance was used.

The length filters (9-15) are specific to vehicle classes. For instance, the 53-foot cargo-carrying length limit applies to the total length of single-unit trucks (Classes 5, 6, and 7), whereas for single-trailer trucks (Classes 8, 9, and 10), this limit is measured from the second axle to the rear axle. By aligning length limits with vehicle class, the filters ensure the accurate interpretation and application of these rules. Additionally, the length filters for Long Combination Vehicles (LCVs) were reviewed considering the designated routes in Alaska. **Appendix E** provides the locations of the Alaska WIM sites and the routes associated with these LCV's length rules. If a WIM site is located on a route that permits LCVs, the appropriate length limits apply to trucks captured at that site. Thus, length limits were matched with both the vehicle class and the WIM site.

This set of legal rules identified Alaska's legal traffic, considering both weight and length limits. The WIM data was processed to filter trucks into two groups: "legal" and "above the legal limit." Trucks that violated any of the developed rules were flagged as "above the legal limits."

The "above legal limit" trucks were further filtered to identify state routine permit traffic with a 25% overload allowance on weights, representing the pool of state routine permits in Alaska. A summary of the WIM legal filtering is shown in **Table 2-9**, where length criteria are distinguished from weight criteria by highlighting the length limits in grey.

Table 2-8: Alaska Legal Load Filters.

No.	Rule	Weight Limit (W) [kips]	Spacing/Length Limit (L) [feet]	Vehicle Class	Condition	Applicable to following WIM Sites
1	Single Axle (1st and 2nd)	20.55	8.1	-	1st & 2nd Axle > 20.55 kip	all
2	Single Axle	20	8.1	-	Any Axle > 20 kip	all
3	Tandem Axle	38	3.5	-	Any spacings < 8.1 & W > 38 kip	all
4	Tridem Axle	42	3.5	-	Any two spacings > 8.1 & < 16.2 W > 42 kip	all
5	Tridem Axle	43.5	5.0	-	Any two spacings > 10 & < 16.2 W > 43.5 kip	all
6	Tridem Axle	45	6.0	-	Any two spacings > 12 & < 16.2 W > 45 kip	all
7	Quad Axle	50	3.5	-	Any three spacing < 24.3 W > 50 kip	all
8	FBF	Equation	-	-	Alaska FBF + 4.5 kips	all
9	Cargo-carrying length	-	53	5,6,7	L < 53 ft	all
10	Cargo-carrying length	-	53	8, 9, 10 (from second axle)	L < 53 ft	1,3,4,6,7,8
11	Single Trailer	-	75	8, 9, 10	L < 75 ft	1,3,4,6,7,8,9
12	Multi Trailer	-	75	11,12,13	L < 75 ft	2,3,4,7,8,9
13	Long Combination Vehicles (a)	-	95	8, 9, 10,11,12,13 (from second axle)	L < 95 ft	2,9
14	Long Combination Vehicles (b)	-	90	8, 9, 10	L < 90 ft	2
15	Long Combination Vehicles (c)	-	95	11,12,13	L < 95 ft	1,6

Table 2-9: Summary of Filtered WIM data

WIM ID	WIM Site	Year	Total Number of Selected WIM Records	Number of “Legal” WIM Records	Number of “Above Legal” WIM Records	Number of Routine Permit WIM Records
1	fox	2022	66,991	55,369	11,622	11,120
2	gln	2023	128,675	111,225	17,450	16,515
3	min	2023	229,166	207,581	21,585	20,093
4	ste	2023	135,851	115,856	19,995	18,612
6	plm	2023	63,275	59,956	3,319	3,005
7	poa	2022	336,951	291,021	45,930	43,274
8	tds	2023	137,403	120,208	17,195	14,513
9	tok	2023	29,342	26,945	2,397	2,170
Total:			1,127,654	988,161	139,493	129,302

Chapter 3: Alaska Legal and Routine Permit Traffic

The Alaska WIM filtering procedure identified legal and state routine permit trucks. Since the legal and routine permit data encompass all Alaska legal loads, combining the data sets for analysis was discussed with the DOT&PF, rather than analyzing them separately. The characteristics of the heaviest 20% of legal and routine permit trucks, as well as their combinations, were evaluated to understand the implications of merging these groups in the development of the Alaska Legal Live Load Model.

Figure 3-1 presents the distribution of GVW and the total vehicle length of the legal and routine permit trucks. The group of routine permit trucks includes vehicles with a GVW of up to 180 kips and 120 feet in length. Also, distributions of axle count for these groups were reviewed (**Figure 3-2**). Legal trucks are dominated by typical 3-axle and 5-axle trucks, and routine permit trucks have a broad distribution of various axles. These trucks are not typical truck configurations, and they represent longer and heavier vehicles.

As Alaska does not have a GVW limit and restricts the vehicle weight based on the combination of axle weight, length, and number of axles, a comparison of Alaska's GVW for legal and routine permit vehicles is shown in **Figure 3-3**. The histogram illustrates the percentage of vehicles exceeding a GVW between 80 and 160 kips. Particularly, the percentage of permit trucks exceeding the federal GVW limit of 80 kips is significantly larger than that of legal trucks.

GVW statistics are presented in **Table 3-1**, showing the percentage of trucks exceeding various GVW thresholds, ranging from 80 to 160 kips in 20-kip increments. The table provides data for a combination of legal and routine permit trucks, indicating that on average 9.3% exceed 80 kips, while 3.7% exceed 100 kips. Additional GVW statistics for legal, permit, and combination of these trucks are available in **Appendix F**.

A review of the legal and routine permit traffic showed that permit traffic includes heavier and longer trucks. Only 10% of Alaska's traffic falls within the state routine permit category, and 88% of Alaska's WIM records correspond to legal traffic. However, the addition of the permit traffic in the Alaska Live Load Model would influence the final results and recommendations of the study. Since Alaska routine permit trucks with a 25% overload allowance are currently rated for legal loads, it would be appropriate to include this portion of traffic in the live load model. Because there was no practical merit in analyzing the legal and permit traffic separately, the decision was made to use the combined legal and routine permit data for the study.

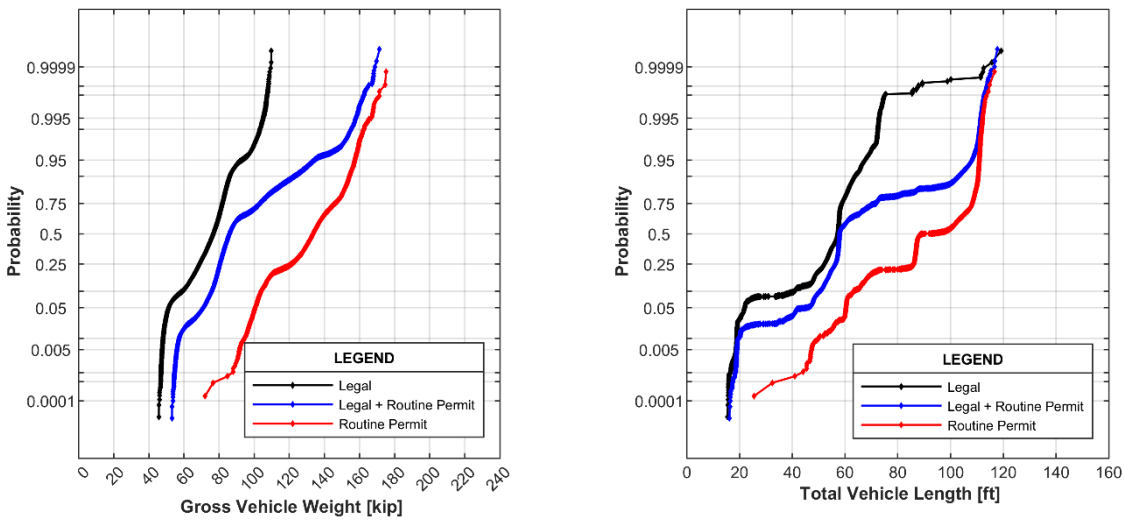


Figure 3-1: Distribution of upper tail (20% largest) GVW and length for legal, routine permit, and combination of legal and routine permit trucks in Alaska for “gln” WIM site

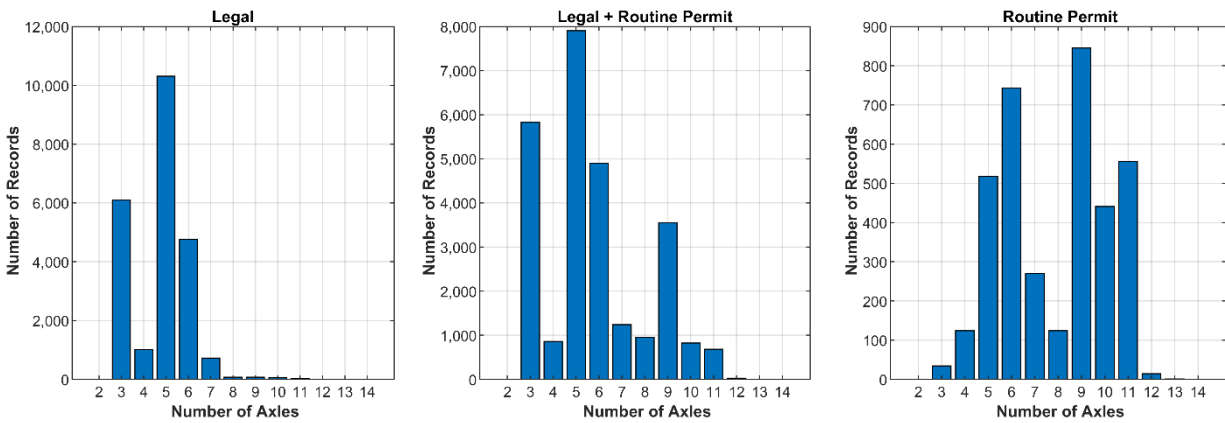


Figure 3-2: Upper tail (20% heaviest trucks) histogram of number of axles for legal, legal and routine permit, and routine permit trucks for “gln” WIM site

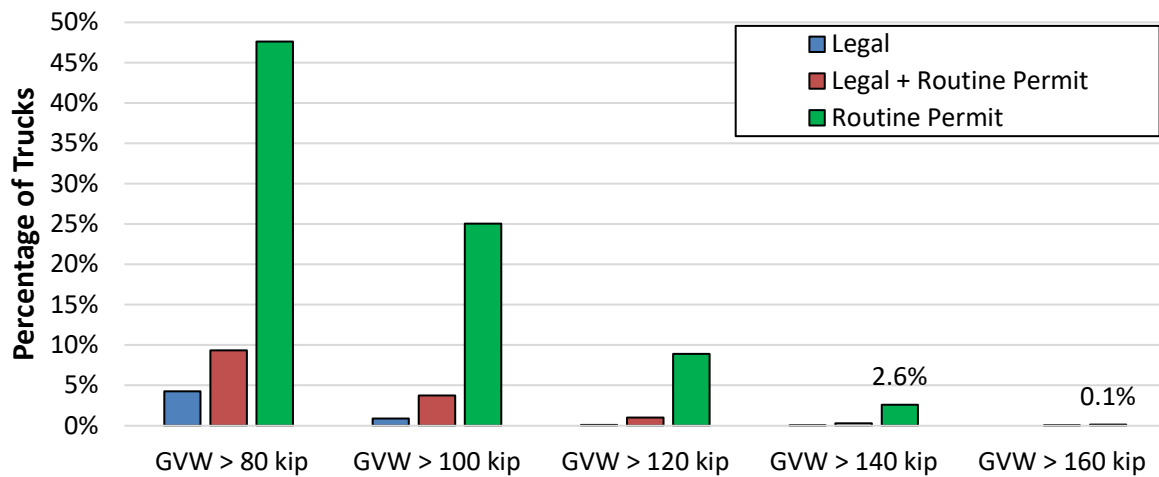


Figure 3-3: Percentage of trucks for all WIM data and upper tail for GVW ranges

Table 3-1: GVW statistics for Legal and Routine Permit traffic in Alaska.

WIM ID	WIM Site	Year	Number of WIM Records	Percentage					Number of Records				
				GVW > 80 kip	GVW > 100 kip	GVW > 120 kip	GVW > 140 kip	GVW > 160 kip	GVW > 80 kip	GVW > 100 kip	GVW > 120 kip	GVW > 140 kip	GVW > 160 kip
1	fox	2022	66,489	20.90%	9.01%	0.66%	0.04%	0.00%	13,897	5,993	438	24	0
2	gln	2023	127,740	16.44%	6.12%	2.57%	0.89%	0.05%	20,995	7,815	3,281	1,131	64
3	min	2023	227,674	3.24%	0.98%	0.24%	0.07%	0.03%	7,376	2,225	538	152	70
4	ste	2023	134,468	7.61%	2.80%	1.12%	0.27%	0.00%	10,234	3,765	1,512	367	0
6	plm	2023	62,961	4.53%	1.95%	1.27%	0.08%	0.00%	2,853	1,225	801	49	1
7	poa	2022	334,295	13.32%	7.12%	1.39%	0.58%	0.03%	44,530	23,818	4,639	1,929	85
8	tds	2023	134,721	1.90%	0.38%	0.12%	0.01%	0.00%	2,554	516	155	13	1
9	tok	2023	29,115	6.71%	1.50%	0.60%	0.37%	0.00%	1,953	438	174	108	0
Total/Avg:			1,117,463	9.30%	3.70%	1.00%	0.30%	0.00%	104,392	45,795	11,538	3,773	221

Chapter 4: Alaska Bridge Inventory

To develop the Alaska Legal Live Load Model for representative bridges, the Alaska bridge inventory was reviewed to identify typical bridge span lengths, material types, and traffic volumes. The most recent National Bridge Inventory (NBI) database from 2023 was used for this analysis. The Alaska NBI data was filtered to include only DOT&PF bridges, distinguishing them from bridges under federal agency responsibility. If a bridge was not identified in the NBI data as managed by a federal agency, DOT&PF was assumed to be the responsible owner. Based on this filtering criteria, 1,077 bridges were included in this review.

Figure 4-1 shows the distribution of bridge maximum span lengths, which ranged from 10 to 300 feet, with most span lengths between 30 and 150 feet. This span range was considered in the development of the Alaska Legal Live Load Model. Additionally, the bridge material types were analyzed, and **Figure 4-2** indicates that the majority of Alaska bridges are made of steel and prestressed concrete. These typical materials were also incorporated into the full probabilistic calibration and included in the dead load and resistance models. Traffic volume in Alaska is lower than in other states. **Figure 4-3** illustrates the Average Daily Truck Traffic (ADTT) distribution on Alaska structures, with most bridges carrying an ADTT below 100. The AASHTO MBE legal load models consider ADTTs of 1,000 and 5,000, and they conservatively encompass Alaska traffic.

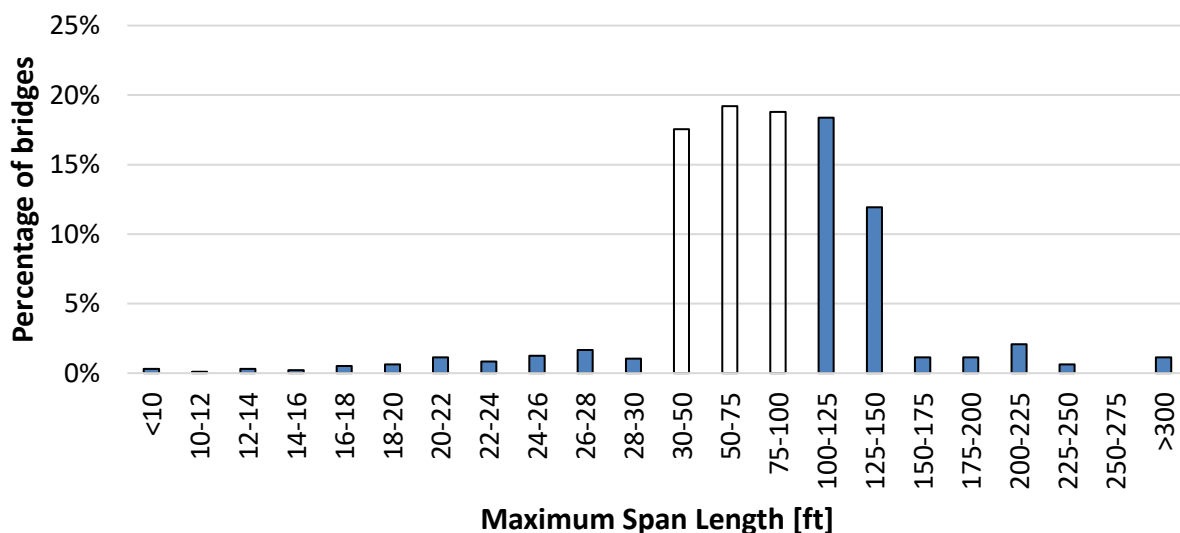


Figure 4-1: Maximum span length distribution of Alaska bridges

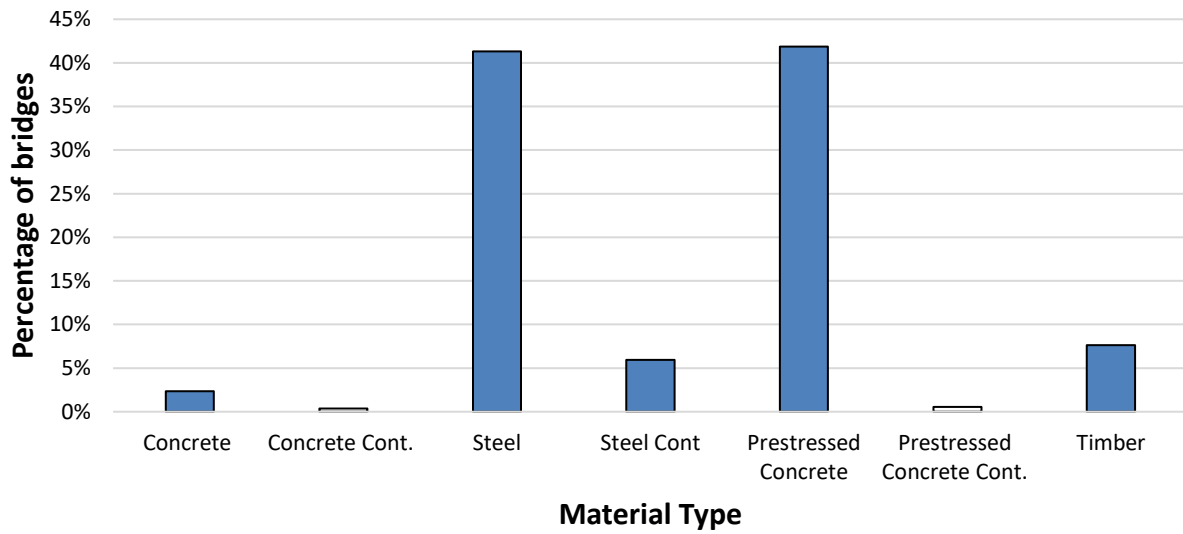


Figure 4-2: Material type distribution of Alaska bridges

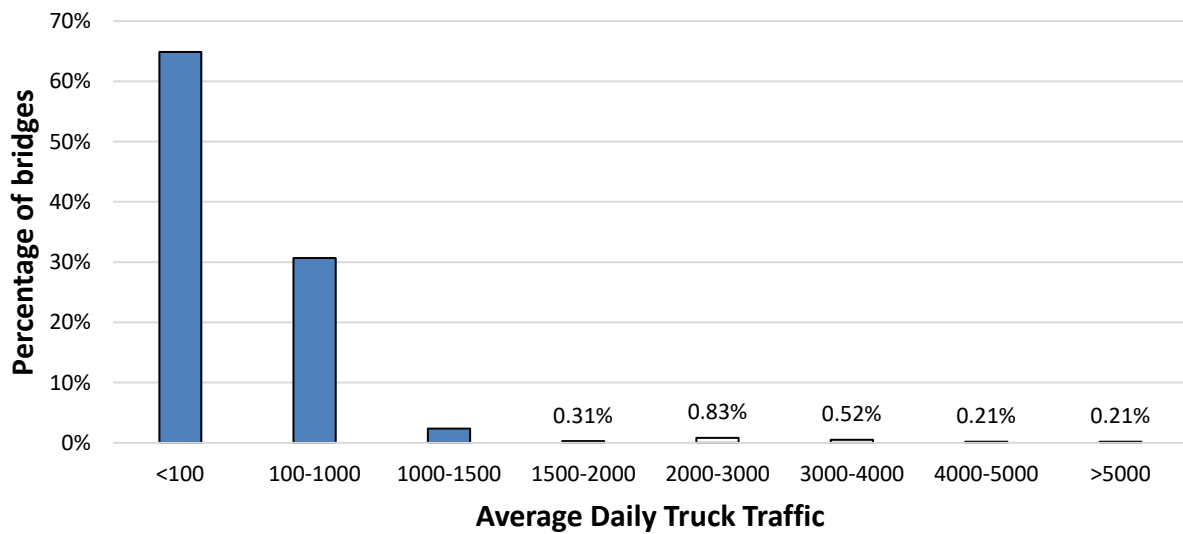


Figure 4-3: Average Daily Truck Traffic distribution of Alaska bridges

Chapter 5: Influence Line Analysis

Influence line analysis was conducted for legal and routine permit WIM data to determine the maximum expected load effects on Alaska bridges. The analysis covered representative bridge span lengths and configurations, including simple span, two-span continuous, and three-span continuous structures. These common bridge types were chosen to develop the Alaska live load envelope. Standard girder spacing and span lengths were assumed, ensuring applicability within the distribution factors outlined in AASHTO specifications. **Figure 5-1** illustrates the considered bridge configurations.

A review of Alaska NBI data showed that most maximum span lengths range from 10 to 300 feet. Therefore, this range was used in the influence line analysis. For short spans, between 10 and 30 feet, two-foot span increments were used. For spans ranging from 50 to 300 feet, increments of 25 feet were applied, resulting in a total of 22 distinct span lengths.

The influence line analysis algorithm was developed in MATLAB to efficiently process large volumes of WIM data. Influence line ordinates for various force effects, corresponding to the span configurations described earlier, were determined using commercial software. The evaluation assumed a prismatic cross-section throughout the structure's length. Influence line ordinates were obtained at 20 equally spaced points providing sufficient accuracy for this analysis. Live load force effects, including moments and shears, were evaluated only at critical locations and are listed below. Throughout this report, symbols used in the description below (M11, S1, M21, M22, S2, M31, M32, M33, S3) will be used to represent load cases.

- For simple span structures:
 - **M11**: Maximum positive moment at midspan
 - **S1**: Maximum end shear
- For 2-span continuous structures:
 - **M21**: Maximum positive moments at 0.4L (both spans)
 - **M22**: Maximum negative moment at the pier
 - **S2**: Maximum shear at the pier
- For 3-span continuous structures:
 - **M31**: Maximum positive at 0.4L (end spans)
 - **M32**: Maximum positive at 0.5L (center span)
 - **M33**: Maximum negative moment at the piers
 - **S3**: Maximum shear at the piers

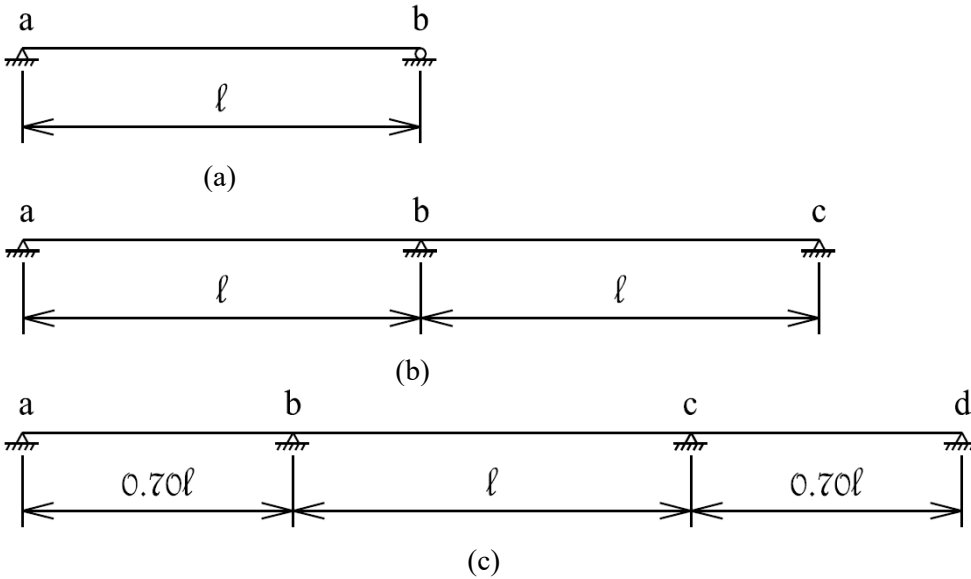


Figure 5-1: Configuration of bridge structure types (a) Simple Span Structures, (b) 2-Span Cont. Structures with Equal Spans, and (c) 3-Span Structures with Unequal Spans.

5.1 WIM Load Effects

Over one million legal and routine permit WIM records were used for the influence line analysis for 22 span lengths and 9 load cases, producing over 2.2 million different force effects.

Figure 5-2 presents the influence line analysis results for a simple span moment case (M11) for the span lengths of 20, 100, and 200 feet. These plots show the Cumulative Distribution Function (CDF) on a normal probability plot. The CDF plot represents the percentage of the WIM records corresponding to specific magnitudes of load effects. The y-axis on a normal probability plot is uniquely scaled, so that plotted values that result in a straight line indicate that the data follows a Normal distribution. The plots show the variability of the traffic-induced load effects and the upper tail distribution, which is used in the development of the Alaska Legal Live Load Model. Additional plots showing the results of the influence line analyses are presented in **Appendix G**.

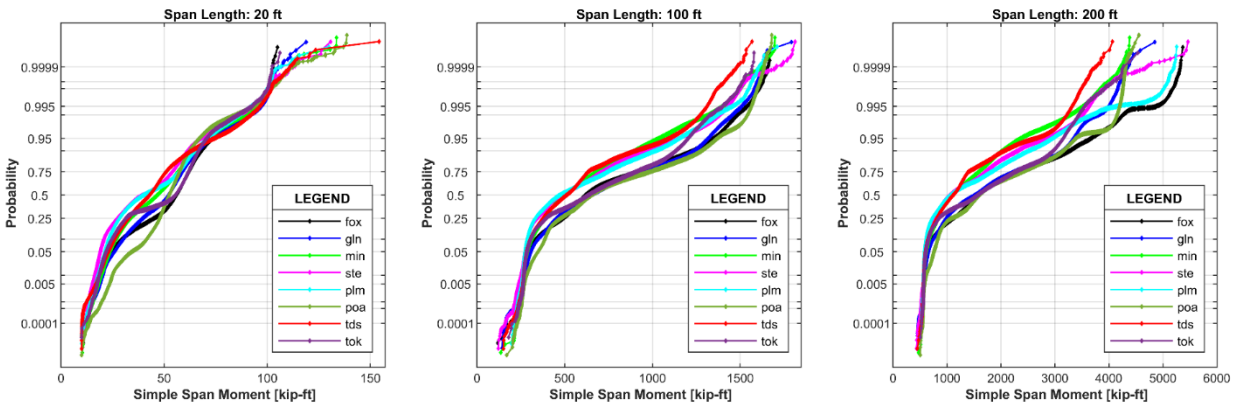


Figure 5-2: Simple Span Moment for short (20 feet), medium (100 feet), and long (200 feet) bridges.

5.2 AASHTO MBE Legal Load Effects

Influence line analyses were also completed to determine the controlling live load effects for the AASHTO MBE legal rating trucks. The AASHTO MBE uses three notional truck configurations to represent routine commercial traffic: Type 3, Type 3S2, and Type 3-3 trucks. Additionally, it incorporates a lane load model for bridges with span lengths greater than 200 feet and includes provisions for negative moment checks. For long-span bridges, the LRFR lane load model applies 75% of the Type 3-3 truck load combined with a lane load of 0.2 klf, and for negative moment checks, it uses two 75% Type 3-3 trucks spaced 30 feet apart with a lane load of 0.2 klf. LFR uses the combination of two Type 3, Type 3S2, and Type 3-3 trucks spaced 30 feet apart for the analysis of long-span bridges. Because the LFR load model creates greater force effects, it was conservative to use calibrated live load factors for LRFR load models. **Appendix H** shows all AASHTO MBE routine commercial configurations. These trucks will be referred to as Legal Rating Trucks (LRT) in this report. An influence line analysis was performed for all AASHTO LRT configurations to determine the maximum live load effects for selected span lengths and load cases. **Appendix J** presents the controlling trucks for all load cases.

Additionally, AASHTO MBE Specialized Hauling Vehicles (SHV) are considered legal loads. The SHVs include four configurations of SU trucks. **Appendix I** shows the configurations of the SU4, SU5, SU6, and SU7 vehicles. Live load effects for these trucks were computed, and the controlling cases are presented in **Appendix J**.

The live load effects of Alaska WIM trucks were compared with the governing load cases for both AASHTO MBE LRTs and SHVs. The computed live load ratios provided a basis for the development of the Alaska Legal Live Load Model.

5.3 AASHTO Design Load Effects

Alaska WIM load effects were also compared to design loads, including HL-93 and HS-20. The configurations of the design trucks are presented in **Appendix K** and **Appendix L**. The controlling load cases are shown in **Appendix M**.

For HL-93, three different configurations were considered.

- **Truck:** design truck with axle weights of 8 kips, 32 kips, 32 kips, spaced 14 ft and a variable second spacing of 14 to 30 ft, and lane load of 0.64 klf
- **Tandem:** tandem with axle weights of 25 kips spaced 4 ft apart, and lane load of 0.64 klf
- **Negative:** truck train that consists of 90% of two trucks spaced 50 ft apart and 90% of a 0.64 klf lane load for a negative moment

For HS-20, four different configurations were considered.

- **Truck:** design truck with axle weights of 8 kips, 32 kips, 32 kips, spaced 14 ft and a variable second spacing of 14 to 30 ft
- **Tandem:** military tandem load with axle weights of 24 kips spaced 4 ft apart
- **Point Lane:** a point load of 18 kips for a moment or 26 kips for shear, and a lane load of 0.64 klf

- **Negative:** two point loads of 18 kips with variable spacing of 4 to 30 feet and a lane load of 0.64 klf for negative moment (although not specified in AASHTO, a variable point load spacing was utilized to maximize negative moments)

Maximum Alaska WIM load effects were compared to the design load effects at the inventory level. The controlling HL-93 truck load was adjusted using a 33% dynamic impact factor and a 1.75 live load factor, and the HS-20 load was multiplied by the dynamic allowance equation based on the AASHTO Standard Specification with a live load factor of 2.17. **Figure 5-3** and **Figure 5-4** show the maximum Alaska load ratios relative to the controlling design load effects at the inventory level. For HL-93, the ratios range from 0.30 to 0.49, while for HS-20, they vary from 0.36 to 0.67. These results indicate that the AASHTO design truck at the inventory level encompasses Alaska legal traffic.

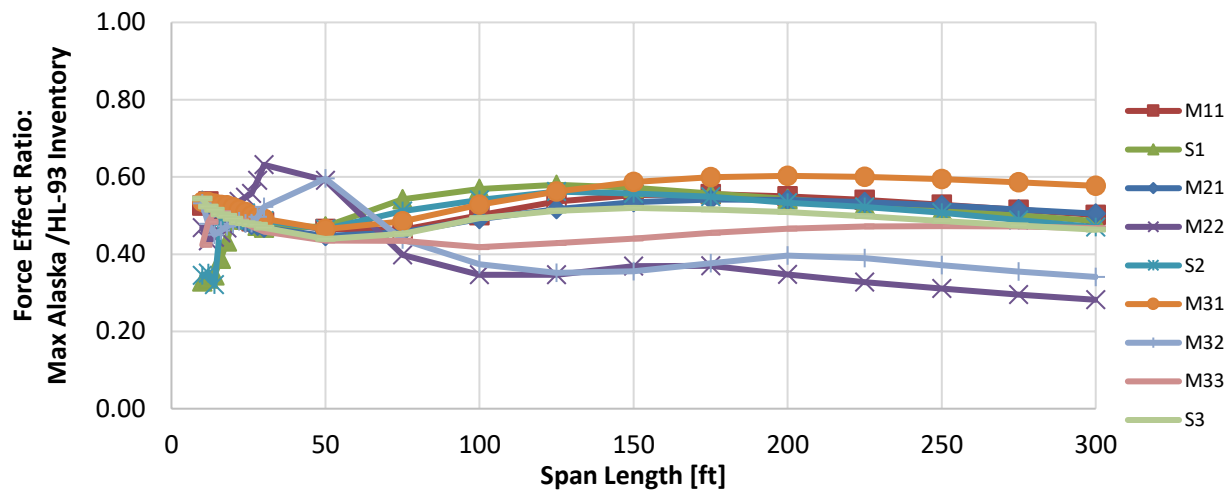


Figure 5-3: Ratio of maximum Alaska WIM force effect to HL-93 loading at the inventory level.

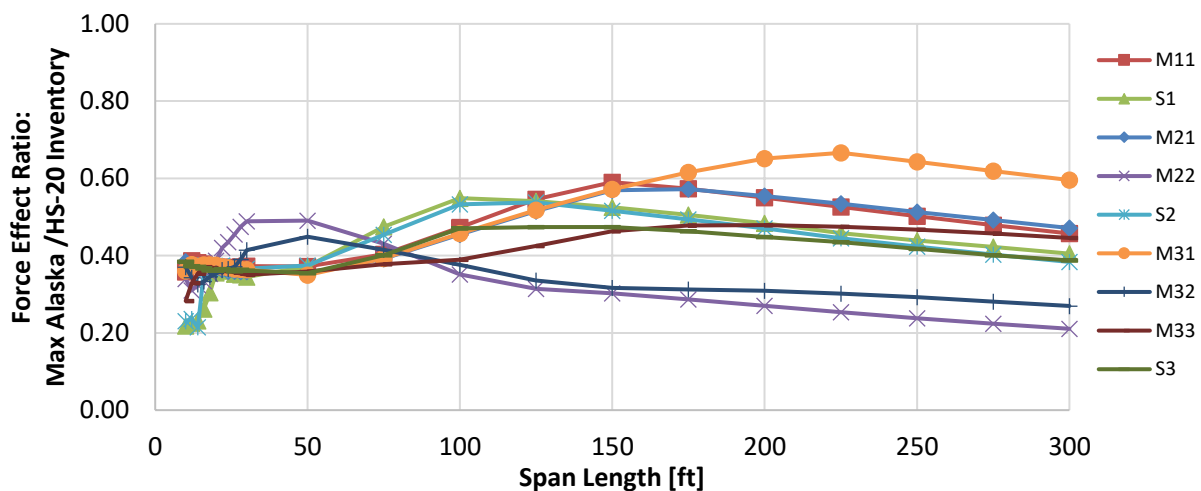


Figure 5-4: Ratio of maximum Alaska WIM force effect to HS-20 loading at the inventory level.

Chapter 6: Reliability-Based Calibration

In AASHTO LRFD, safety is provided in terms of load and resistance factors determined from a reliability-based calibration. The acceptance criteria for safety factors is to keep the probability of failure at an acceptably low level to meet the target reliability index. Code calibration is conducted for a limit state function, which is the mathematical representation of the acceptable (safe) and unacceptable (failure) performance. In a simple case, R represents the resistance and L represents the load; the limit state function can be formulated as $g = R - L > 0$. The value of g is the safety margin, so if the value of the limit state function is greater than or equal to zero, the structure is safe, but if it is less than zero, it fails. In probabilistic calibration, both load and resistance are treated as random variables and are subject to considerable variation, depending on material properties, quality of workmanship, accuracy of the analytical model, etc. To address the variability, statistical models are developed to describe these random variables.

The statistical model is defined by a bias factor, coefficient of variation (COV), and distribution type. The bias factor is the ratio of the actual to nominal value. The coefficient of variation is a measure of the variability of the data and is equal to the standard deviation divided by the mean. Additionally, the distribution type is used to determine the probability of failure, critical for the reliability assessment. By incorporating probabilistic methods and considering statistical models, the calibration process results in live load factors that provide appropriate safety levels prescribed by the specifications.

The probabilistic calibration involves several key steps, beginning with the definition of the limit state function and the development of statistical parameters. This is followed by the selection of a simulation technique and the calculation of load and resistance factors required to achieve a minimum acceptable reliability index β , not less than the target reliability index, β_T . The general calibration procedure used in this project is described below:

- 1) *Formulation of Limit State Function* – strength limit state was used as a rating equation.
- 2) *Selection of Representative Bridges* – based on the Alaska bridge inventory, bridge span lengths ranging from 10-300 feet were considered. This includes simple span, two equal span continuous, and three unequal span continuous structures.
- 3) *Development of Statistical Models for Load and Resistance* – dead load and resistance models were adapted from previous AASHTO calibrations, while the Alaska Legal Live Load Model was developed using WIM data analysis.
- 4) *Determination of a Reliability Analysis Procedure* - a Monte Carlo simulation was used for calibration. Random variables, such as dead load, live load, and resistance, were simulated using the respective distributions and statistical parameters to evaluate structural safety in terms of the reliability index.
- 5) *Selection of the Target Reliability Index* – according to AASHTO MBE, a target reliability index, β_T is 2.50, and it was selected for the operating level calibration.

- 6) *Calculation of Live Load Factor* - calibration results in a live load factor that envelopes Alaska legal traffic at the target safety at the operating level.
- 7) *Verification of Reliability Indices and Recommendations* – calibrated live load factors are reviewed, and a single value of the live load factor is selected and verified by assessing the level of safety in terms of the reliability index. Based on these results, recommendations for Alaska bridge rating procedures were provided.

6.1 Alaska Legal Live Load Model

A statistical model was developed to capture the variability of traffic-induced load effects on Alaska bridges using a WIM legal live load envelope. This chapter presents the development of the Alaska Legal Live Load Model.

6.1.1 Development of Statistical Parameters

The live load statistical parameters contain the bias factor and coefficient of variation. The bias factor is the ratio of the maximum expected live load effects to the nominal live load caused by the notional truck(s). In this study, the bias factor is the ratio of the maximum expected Alaska legal load effects to the AASHTO MBE LRT and SHV load effects. The distribution of live load ratios is then used to determine the maximum expected live load ratio (bias factor). The development of the Alaska bias factor required the following steps:

- 1) Selection of the upper tail – determine the percentage of the largest load ratios that represent Alaska legal traffic.
- 2) Distribution fitting – identify the distribution type that best fits the selected upper tail data.
- 3) Extrapolation – projection of the upper tail load ratio distribution for a given period and traffic volume to estimate the maximum expected load ratio.

The upper tail is selected based on the percentage of the largest live load ratios. This study explored various upper tail percentages, including tails of 5%, 10%, 15%, and 20%. The original AASHTO LRFD calibration used a 20% upper tail to represent the heaviest trucks, while the AASHTO MBE offered a simplified approach using a 5% upper tail based on WIM data. Thus, the study examined a range between 5% and 20%. The analysis indicated that the smaller upper tail percentages resulted in lower bias factors, suggesting that smaller upper tail percentages do not accurately represent the distribution of heavy traffic in Alaska. Due to the low traffic volumes at Alaska WIM sites, smaller upper tails provide small WIM sample sizes, which increase the slope of the upper tail distribution and consequently reduce the extrapolated bias factors. Thus, it was concluded that a 20% upper tail more accurately represents Alaska traffic, and it was selected for the development of the Alaska Legal Live Load Model. The upper 20% tail of the largest WIM-to-AASHTO load effect ratios for each span and load case was analyzed to determine the best-fit distribution type. A distribution fitting algorithm evaluated several

distribution types, including Normal, Lognormal, Beta, Extreme Value, Gamma, Generalized Extreme Value, and Weibull. The analysis identified Normal distribution as the best fit for the Alaska live load distribution. To enhance accuracy, an outlier detection filter was applied to reduce the influence of atypical truck loads on the Normal distribution fitting. This process excluded the heaviest 0.1% of trucks by trimming the upper tail beyond three standard deviations. By filtering out these outliers representing non-typical legal configurations, the model more accurately captured the Alaska Legal Live Load using Normal distribution.

The live load varies with time, and its characteristics depend on a specific “return period”. To determine the bias factor for an extended return period, an extrapolation method is required. AASHTO LRFD utilizes a design life of 75 years for calibration, and this means that the return period for design is 75 years. For AASHTO MBE, the return period is specified as 5 years which represents the evaluation period. The extrapolation necessitates the selection of an ADTT to estimate the number of trucks crossing the bridge within the return period to find the maximum expected live load ratios. In this study, the annual WIM data was extrapolated to a 5-year return period with ADTT values of 1,000 and 5,000 to follow the AASHTO MBE provisions. Additionally, the extrapolation process accounts for the probability of side-by-side truck occurrences. The AASHTO live load model was developed for the fully correlated two-lane load model. AASHTO side-by-side occurrence for an ADTT of 5,000 is specified as 1/15, and 1/100 for an ADTT of 1,000. Given that this analysis uses the upper tail of 20%, the extrapolated number of trucks was adjusted accordingly. For example, the expected number of trucks crossing the bridge within 5 years for an ADTT of 5,000 is calculated as follows (365 days) (5 years) (5000 trucks/day), which results in 9,125,000 trucks. This number is then reduced to account for 20% of the upper tail and the multiple presence of 1/15, resulting in 121,667 trucks. So, the probability of exceeding the maximum load is expressed as $(1 - 1/121,667)$. This probability is converted to a corresponding z-value, which is the inverse of the standard normal variable, yielding a value of 4.3. Thus, the bias factor is the maximum expected live load ratio that corresponds to a z-value of 4.3. **Figure 6-1** illustrates the upper tail extrapolation process, where the 20% upper tail was selected, a Normal distribution was fitted to the data, and the bias factor at the corresponding probability (standard normal inverse z-value) was determined.

The extrapolation process was performed across all WIM sites, span lengths, and load scenarios to develop the Alaska Legal Live Load Model. **Figure 6-2** shows an example of the captured live load ratios and extrapolated ratios for the ADTT of 1,000 and 5,000. On average, there is an increase of 2% to 5% for the ADTT of 1,000 and about 8% to 14% for the ADTT of 5,000. Thus, the extrapolation increases the maximum live load ratios captured in the WIM data.

The coefficient of variation is taken as a variation of the bias factor between the WIM sites. It represents the variability of the traffic from site to site to provide an Alaska-specific Live Load Model.

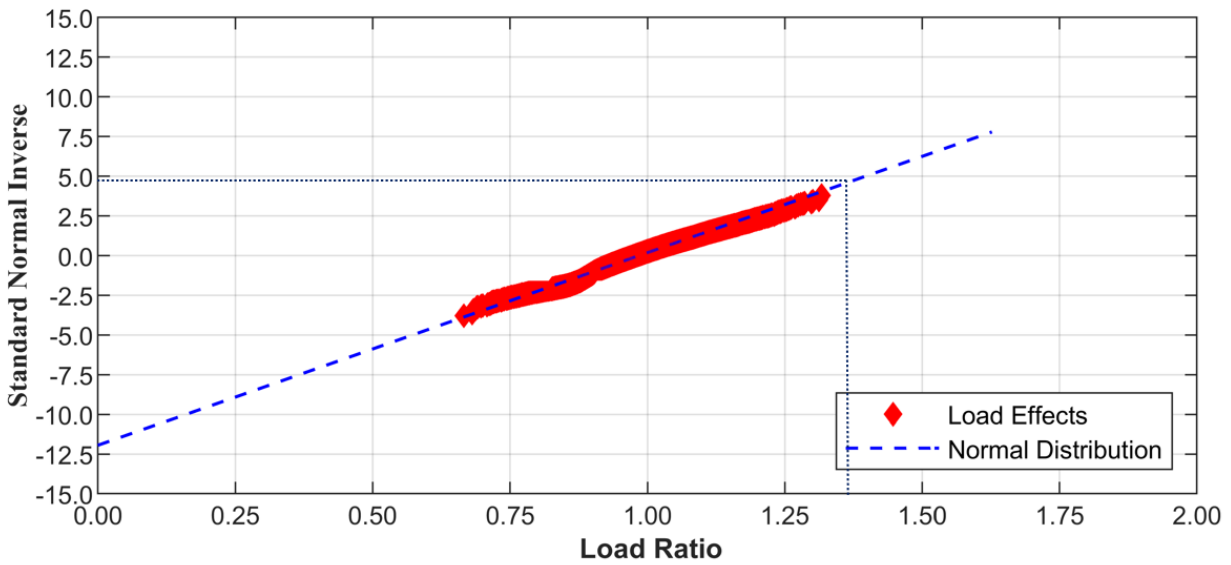


Figure 6-1: Maximum WIM, and Extrapolated Bias Factors for Alaska Traffic.

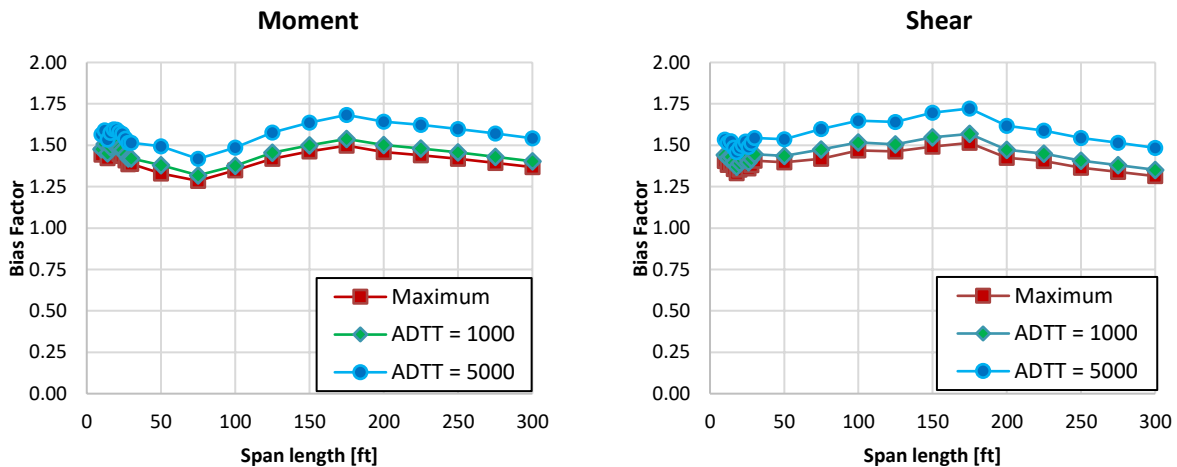


Figure 6-2: Extrapolated bias for Alaska Legal WIM traffic and AASHTO LRT.

6.1.2 Selection of Statistical Parameters

The Alaska Legal Live Load Model developed maximum expected live load ratios between the Alaska legal WIM traffic and the controlling AASHTO MBE legal trucks. These ratios were then extrapolated, and bias factors were determined for all WIM sites and selected bridge structure types, load effects, and span lengths. Bias factors were developed for ADTTs of 1,000 and 5,000 for the AASHTO MBE LRTs and SHVs.

To develop the Alaska Legal Live Load Model, representative bias factors were selected based on computed values. Over 3,000 bias factors were calculated for AASHTO MBE LRT and SHV

load cases. For each span length and load case, a weighted average bias factor was determined using traffic volume at each WIM site as the weighting parameter. This method produced bias factors above the average, better reflecting Alaska's legal loads. **Table 6-1** provides an example of the weighted average bias factor calculation for a simple span moment (M11) case, where each WIM site's bias factor is weighted by its traffic volume share.

Table 6-1: Weighted Average Bias Factor for Simple Span Moment Case (M11)

WIM Traffic Volume [%]	6%	11%	20%	12%	6%	30%	12%	3%	Selected Bias	COV
Span [ft]/WIM Site	1 (fox)	2 (gln)	3 (min)	4 (ste)	6 (plm)	7 (poa)	8 (tds)	9 (tok)		
10	1.22	1.26	1.55	1.59	1.48	1.46	1.42	1.21	1.44	10%
12	1.25	1.26	1.51	1.54	1.44	1.42	1.38	1.20	1.42	8%
14	1.27	1.27	1.49	1.52	1.42	1.39	1.37	1.21	1.40	7%
16	1.29	1.27	1.48	1.51	1.41	1.38	1.36	1.22	1.39	7%
18	1.31	1.28	1.47	1.49	1.40	1.37	1.36	1.23	1.39	6%
20	1.32	1.28	1.47	1.48	1.39	1.36	1.36	1.24	1.38	6%
22	1.33	1.29	1.46	1.48	1.39	1.35	1.36	1.25	1.38	5%
24	1.34	1.30	1.46	1.47	1.39	1.35	1.35	1.25	1.38	5%
26	1.35	1.30	1.46	1.47	1.39	1.35	1.36	1.26	1.38	5%
28	1.36	1.31	1.46	1.48	1.39	1.35	1.36	1.27	1.39	5%
30	1.36	1.32	1.46	1.48	1.39	1.35	1.36	1.27	1.39	5%
50	1.24	1.25	1.33	1.37	1.32	1.24	1.26	1.22	1.28	4%
75	1.27	1.33	1.27	1.30	1.34	1.32	1.16	1.21	1.28	5%
100	1.38	1.42	1.30	1.35	1.42	1.41	1.19	1.26	1.35	6%
125	1.45	1.52	1.32	1.41	1.47	1.50	1.21	1.31	1.41	7%
150	1.50	1.60	1.35	1.48	1.51	1.57	1.23	1.35	1.46	8%
175	1.52	1.65	1.37	1.52	1.54	1.62	1.24	1.38	1.50	9%
200	1.47	1.61	1.32	1.48	1.48	1.57	1.20	1.34	1.45	9%
225	1.44	1.59	1.29	1.46	1.45	1.55	1.17	1.32	1.43	9%
250	1.42	1.57	1.27	1.44	1.42	1.53	1.15	1.29	1.40	9%
275	1.39	1.54	1.24	1.41	1.39	1.50	1.12	1.27	1.38	10%
300	1.36	1.52	1.21	1.39	1.36	1.47	1.10	1.24	1.35	10%

The weighted average biases were computed for every span and load case. All moment effects (M11, M21, M22, M31, M32, and M33) were used to determine the maximum bias factor for the moment. Similarly, the maximum bias factor for shear was selected. The maximum moment and shear bias factors for the Alaska Legal Live Load Model, as applied to the AASHTO MBE LRTs, and SHVs are presented in **Figure 6-3** and **Figure 6-4**.

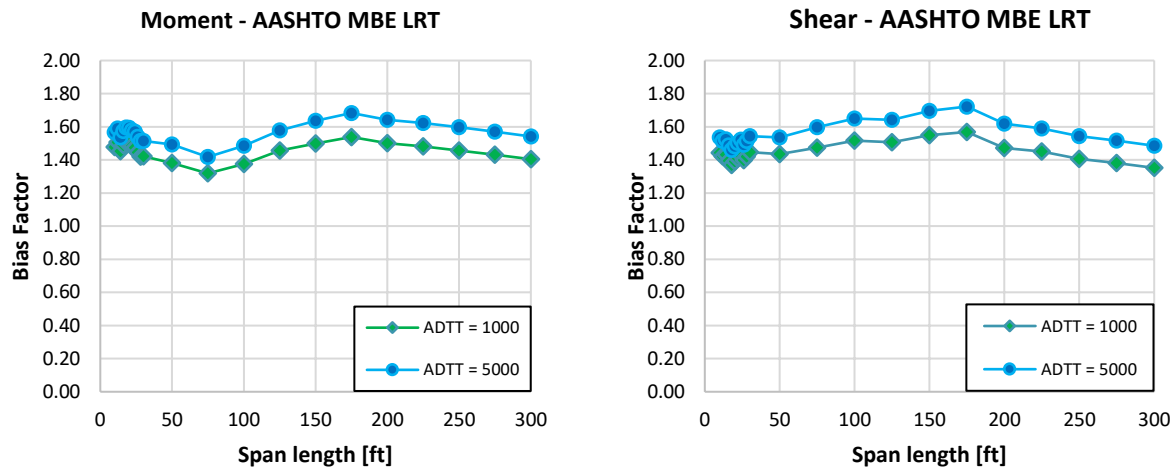


Figure 6-3: Bias Factor for AASHTO MBE Legal Rating Truck (LRT).

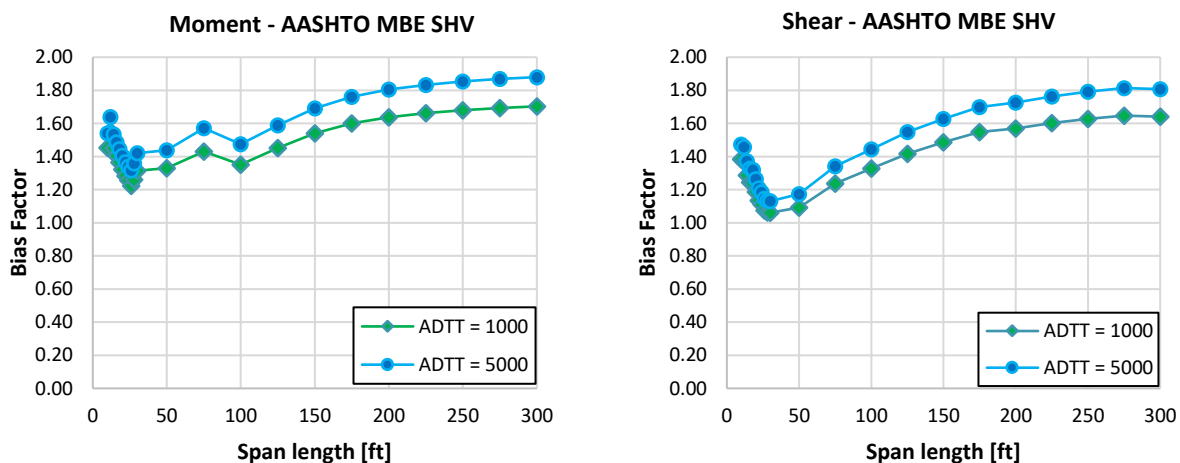


Figure 6-4: Bias Factor for AASHTO MBE Specialized Hauling Vehicles (SHV).

For an ADTT of 1,000, bias factors for LRTs ranged from 1.32 to 1.54 for moment and 1.35 to 1.57 for shear. For an ADTT of 5,000, the bias factors ranged from 1.42 to 1.68 for flexure and 1.46 to 1.72 for shear. The developed bias factors show that AASHTO MBE LRTs effectively represent Alaska legal traffic. The consistency of the bias factors (**Figure 6-3**) suggests that a single live load factor will maintain a uniform level of safety. The purpose of the notional live load model is not to replicate actual truck configurations but to establish uniform statistical parameters applicable to a wide range of bridges. When combined with the calibrated live load factor, the notional live load model shall ensure a consistent safety margin and effectively control the probability of failure.

In contrast, the results for the SHV bias factors show significant variation with span length. This indicates that the SHV load model does not effectively represent Alaska legal traffic. For an

ADTT of 1,000, bias factors for SHVs ranged from 1.22 to 1.70 for moment and 1.06 to 1.65 for shear. For an ADTT of 5,000, the bias factors ranged from 1.32 to 1.88 for flexure and 1.13 to 1.81 for shear. Significant variation is observed in short-span bridges (10 - 30 feet), where bias factors decrease as span length increases. This is due to differences in Alaska's legal truck configurations and SHVs. Alaska allows a 25% increase in axle weight, meaning short spans are governed by heavy axle loads. However, for longer spans, the closely spaced axles of SHV trucks dominate over Alaska legal truck configurations, making SHV trucks unsuitable for long-span bridges. For spans over 100 feet for moment and over 50 feet for shear, bias factors increase with span length. This indicates that SHV trucks, with their short, closely spaced axles, do not effectively represent Alaska's longer legal trucks. Additionally, the absence of a lane load in SHV models makes them unsuitable for long-span bridges. The developed bias factors suggest that SHV trucks do not provide consistent statistical parameters and may not accurately represent Alaska's legal and routine permit traffic. Recommendations regarding SHV applicability will be made following a review of the calibration results.

The coefficient of variation was computed for every span length and load case, and maximum variations were selected for flexure and shear. The COV varies between 8% to 15%. These values will be used as input for the full calibration.

6.2 Dead Load Model

For calibration purposes, a dead load model is required. This model aims to account for the variations between predicted and actual self-weight. In the original AASHTO calibration, the dead load model distinguished between prefabricated and cast-in-place elements, as well as wearing surface. The current AASHTO MBE dead load factors have separate load factors for structural components and wearing surface. **Table 6-2** presents the dead load statistical parameters and load factors used in the probabilistic calibration. Dead load is assumed to be normally distributed. These parameters are consistent with original AASHTO LRFD calibration efforts (NCHRP 368).

Table 6-2: Dead load statistical parameters and load factors.

Dead Load Component		Bias Factor	COV	Load Factor
D1	Prefabricated	1.03	8%	1.25
D2	Cast in place	1.05	10%	1.25
D3	Wearing surface	1.00	25%	1.50

Dead load varies not only with material type but also with span length. While shorter bridges are primarily influenced by live load, the significance of dead load becomes more pronounced in longer-span bridges. This correlation between dead load and live load was investigated to refine the accuracy of the dead load model. Available bridge inventory data was used to examine the dead load to live load ratio for a wide range of bridges. A dead load to live load ratios (D/L)

database, developed by others utilizing AASHTOWare BrR and over 3,000 bridge locations, was used to develop the dead load model.

The D/L data was analyzed to assess the correlation between the bridge span length and material type. The D/L ratios for steel and concrete bridges were grouped by span ranges from 10 to 300 feet. The analysis of D/L ratios for different span length ranges in flexure and shear revealed that there is no linear correlation between dead load and span lengths. However, specific ranges of D/L ratios were identified for each span range.

Natural variability associated with bridge dead load was incorporated into the dead load model. As a result, variable D/L ratios for selected span ranges were used to account for the dead load spectra of Alaska bridges. Separate D/L ratio distributions were developed for steel and concrete bridges within each span length group for flexure and shear. These distributions were characterized by the minimum (5th percentile) and maximum (95th percentile) of available D/L ratios. Due to the varying sample sizes of D/L data across span length groups, minor adjustments were made to capture the trend between D/L ratios and span lengths. For groups with smaller sample sizes, interpolation methods were used to determine representative D/L ranges.

Figure 6-5 presents the D/L ranges that were used in the calibration procedure. For spans between 10-30 feet, the same D/L was used. Additionally, the wearing surface dead load to live load ratios (DW/L) were developed and incorporated into the full calibration procedure. The DW/L ratios vary from 0.01 to 0.40.

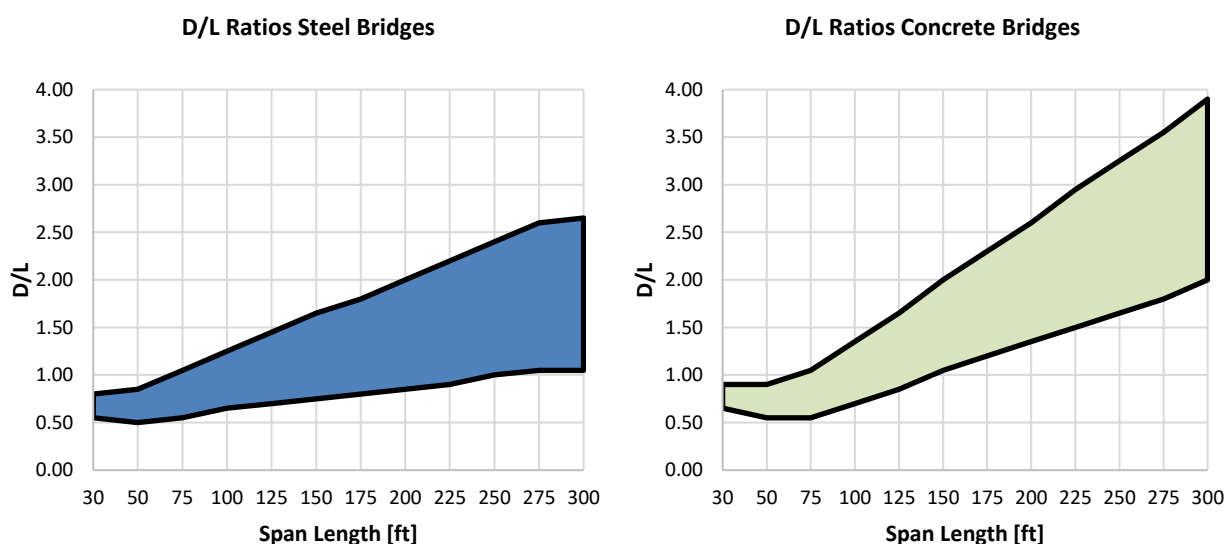


Figure 6-5: Dead Load to Live Load Ratios (D/L) for Steel and Concrete Bridges

6.3 Resistance Model

The resistance model can be considered as a function of three factors, reflecting uncertainty in material properties (strength, modulus of elasticity), dimensions (length, moment of inertia), and the accuracy of the analytical model to represent actual behavior. To treat these uncertainties as random variables, the statistical parameters of resistance are determined by lab tests, field measurements, and simulations. Resistance parameters were considered for steel, reinforced concrete, and prestressed concrete bridges for various load effects. Similar to past calibrations, resistance was assumed to follow a lognormal distribution. **Table 6-3** presents statistical parameters used for the resistance that follows the original AASHTO LRFD calibration (NCHRP 368).

Table 6-3: Statistical Parameters of Resistance

Bridge Material	Flexure		Shear	
	Bias Factor	COV	Bias Factor	COV
Steel	1.12	10.0%	1.14	10.5%
Reinforced Concrete	1.14	13.0%	1.20	15.5%
Prestressed Concrete	1.05	7.5%	1.15	14.0%

6.4 Calibration Approach

The calibration of the AASHTO MBE at the operating level for LRF and SHV notional trucks, using the Alaska Legal Live Load Model, was performed to determine live load factors that meet the target reliability index of 2.50. Rating at the strength limit state requires simulating dead load, live load, and resistance. The safety of the structure is assessed by evaluating the limit state, where the probability of failure corresponds to the probability that the limit state function value falls below zero. The developed statistical models (bias factor and COV) for Alaska Legal Live Load, dead load, and resistance were presented in the previous sections and are used to represent the natural variability of these random variables.

Error! Reference source not found. presents the flowchart with an iterative calibration procedure utilized in this study. The calibration procedure began with the calculation of the governing nominal live load effects for flexure and shear for LFR and SHV trucks. Then, the nominal dead load was computed based on the nominal live load and representative range of dead load to live load ratios shown in **Figure 6-5**. The uniform values between the minimum and maximum ratios for every span length were used to determine nominal dead loads. For each span length, twenty different values between the minimum and maximum dead load to live load ratios were simulated to represent the variability of dead load. Based on the calculated nominal live load and dead load, the iterative procedure began where the iteration considers the variable live load factor ranging from 1.00 to 2.50 in 0.05 increments. The minimum required nominal resistance was calculated based on factored demands. The nominal values of live load and dead load were used along with the dead load factors and resistance factors, depending on the load case (flexure,

shear) and bridge material type (steel, reinforced concrete, and prestressed concrete). The required nominal resistance was computed for the variable dead load to live load ratios. The live load, dead load, and resistance were simulated a million times using the distribution type, bias factors, and coefficient of variation defined in the statistical models. The simulated load and resistance values were used to calculate the limit state function and determine the probability of failure based on several simulated cases where the limit state function was below zero. For each iteration (different live load factor), the reliability index beta was calculated. The calibration was set up to determine the live load factor that provides a reliability index close to the target reliability index of 2.50 per the AASHTO MBE. Computed live load factors were then analyzed and reviewed to recommend a single live load factor that encompasses Alaska legal traffic.

6.5 Calibration Results

The developed calibration procedure was carried out in two different steps: 1) Calculate the live load factor to achieve a target reliability index of 2.50 per the AASHTO MBE at the operating level, and 2) Calculate the reliability index for the selected live load factors. This section presents the results of the calibration for AASHTO MBE LRT and SHV trucks for an ADTT of 1,000 and 5,000.

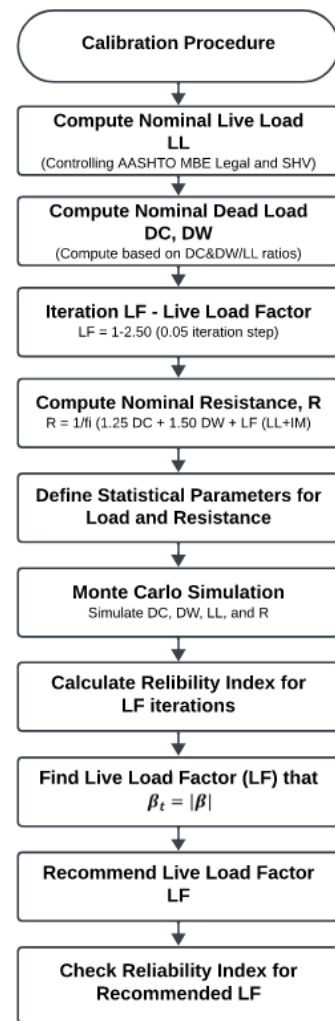


Figure 6-6: Probabilistic Calibration Approach

6.5.1 Calibration of Live Load Factor

In the first step, the live load factor for the AASHTO MBE legal trucks was computed to encompass Alaska traffic and provide the minimum required safety at the target reliability index. **Figure 6-7** and **Figure 6-8** present the calibrated live load factors for AASHTO MBE LRTs for moment and shear and an ADTT of 1,000 and 5,000. The calibration was conducted for steel, reinforced concrete, and prestressed concrete bridges. The resistance model and appropriate resistance factors were used. The calibrated live load factor for an ADTT of 1,000 ranges from 1.20 to 1.60, where the average live load factor was between 1.40 to 1.50. The live load factors for an ADTT of 5,000 varied between 1.35 to 1.75 with an average value between 1.55 to 1.65. The computed live load ratios provide a consistent distribution of values over the span lengths. Small differences are noted for different bridge material types. The controlling material type was used to further select the live load factor. These calibrated live load factors show that the AASHTO MBE LRTs (see **Appendix H**) can be used to represent Alaska legal traffic, and no additional notional trucks are required for the bridge rating procedures. Live load factors

between 1.40 to 1.65 were reviewed in the next step to determine the reliability indices for recommended live load factors.

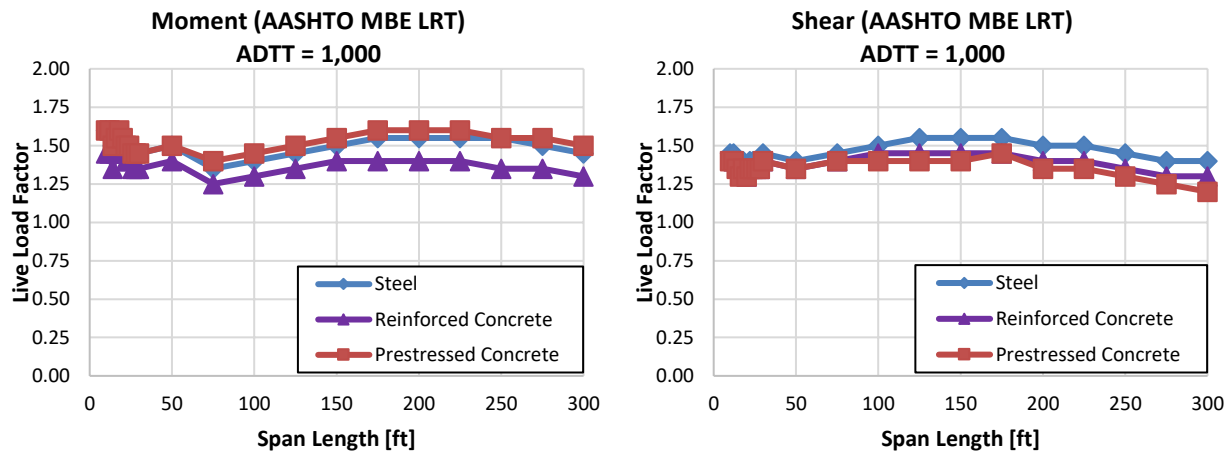


Figure 6-7: Calibrated Live Load Factors for AASHTO MBE LRT, and ADTT = 1,000

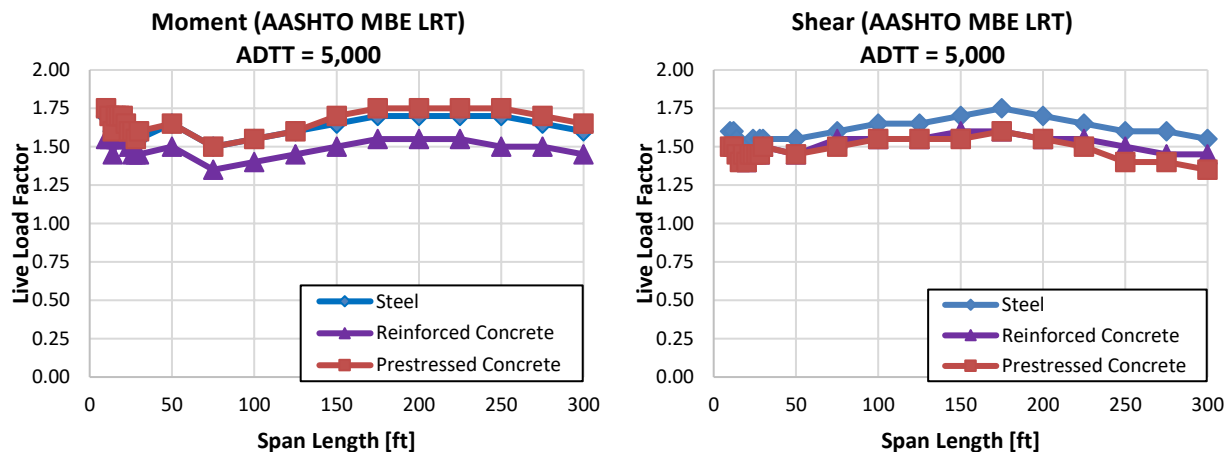


Figure 6-8: Calibrated Live Load Factors for AASHTO MBE LRT, and ADTT = 5,000

Figure 6-9 and **Figure 6-10** present the calibrated live load factors for AASHTO MBE SHVs for moment and shear and an ADTT of 1,000, and 5,000. The calibrated live load factor for an ADTT of 1,000 ranges from 1.00 to 1.75. The live load factors for an ADTT of 5,000 varied between 1.05 to 1.95. This wide variation indicates that SHVs cannot be represented by a single live load factor. Significant variation is observed in short-span bridges (10 to 30 feet), where the live load factor decreases as span length increases. Additionally, for longer spans (over 50 feet), the calibrated live load factor increases with span length. This suggests that SHVs do not adequately account for Alaska's heavy axle loads on short spans and are not suitable for longer and heavier trucks on longer-span bridges. Thus, SHV configurations are not effective candidates for Alaska notional rating trucks. The live load factor could be adjusted for different span lengths, but it is recommended to keep the process simple and utilize a single representative live

load factor for all span lengths. Therefore, it was again proved that SHVs do not accurately represent Alaska's legal and routine permit traffic and will not be used as notional rating trucks.

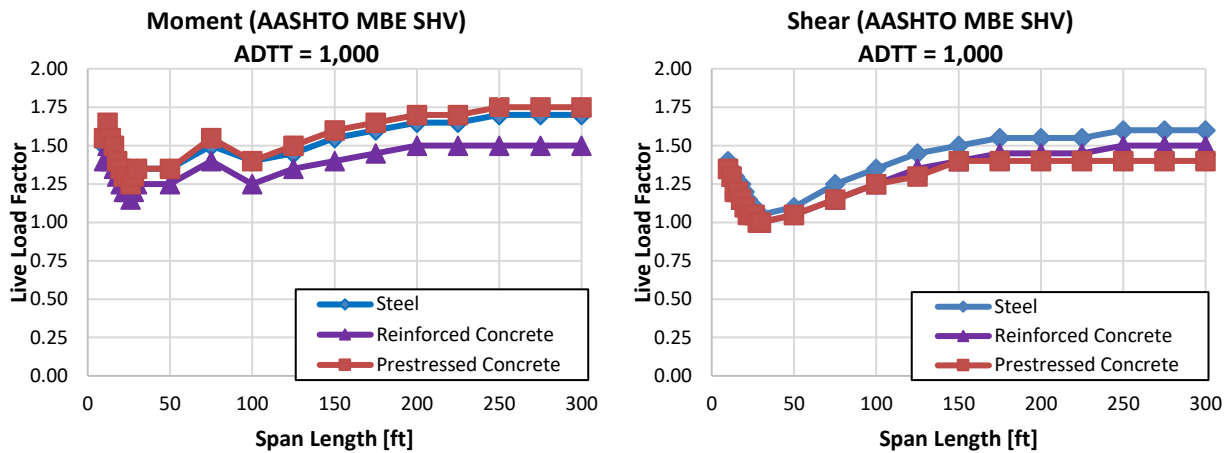


Figure 6-9: Calibrated Live Load Factors for AASHTO MBE SHV, and ADTT = 1,000

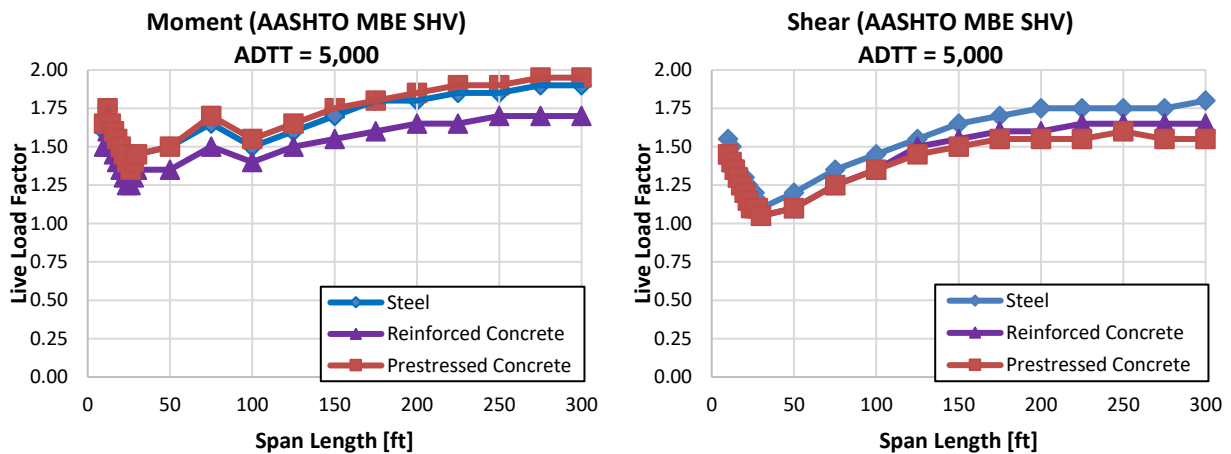


Figure 6-10: Calibrated Live Load Factors for AASHTO MBE SHV, and ADTT = 5,000

6.5.2 Calculation of Reliability Index

The second calibration step is a selection of live load factors and assessment of the resulting reliability index. Since the average calibrated live load factors for AASHTO MBE LRTs range from 1.40 to 1.65, a reliability analysis was conducted for these values to evaluate safety in terms of the reliability index. The results are shown only for steel bridges because they govern shear load effects and yield comparable controlling values to prestressed concrete bridges. **Figure 6-11** presents a reliability index for the selected live load factors of 1.40, 1.45, and 1.50 for the AASHTO MBE LRTs, and ADTT of 1,000 for moment and shear. Similarly, **Figure 6-12** shows the reliability index for the live load factors of 1.55, 1.60, and 1.65, for an ADTT of 5,000 for moment and shear.

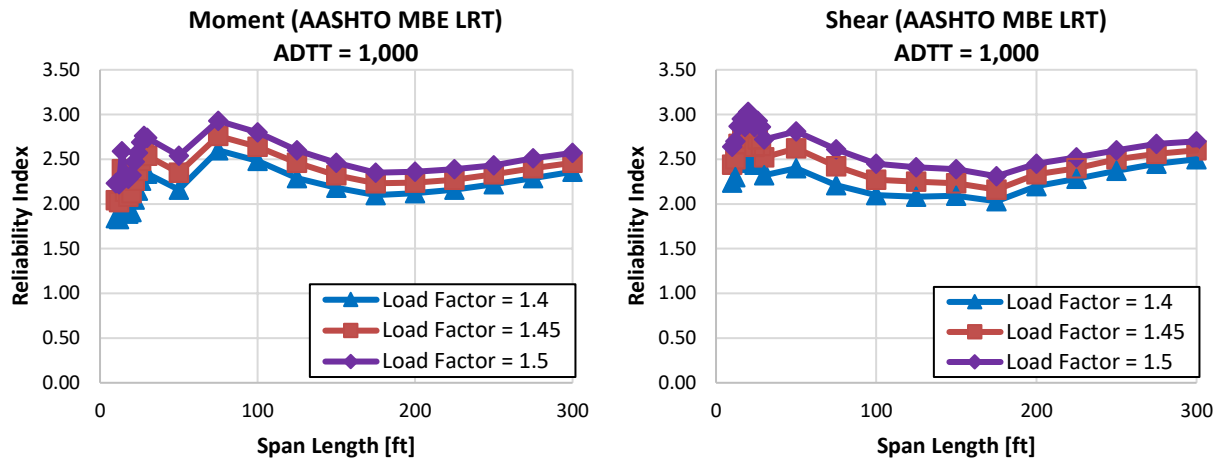


Figure 6-11: Reliability index for AASHTO MBE LRT, and ADTT = 1,000

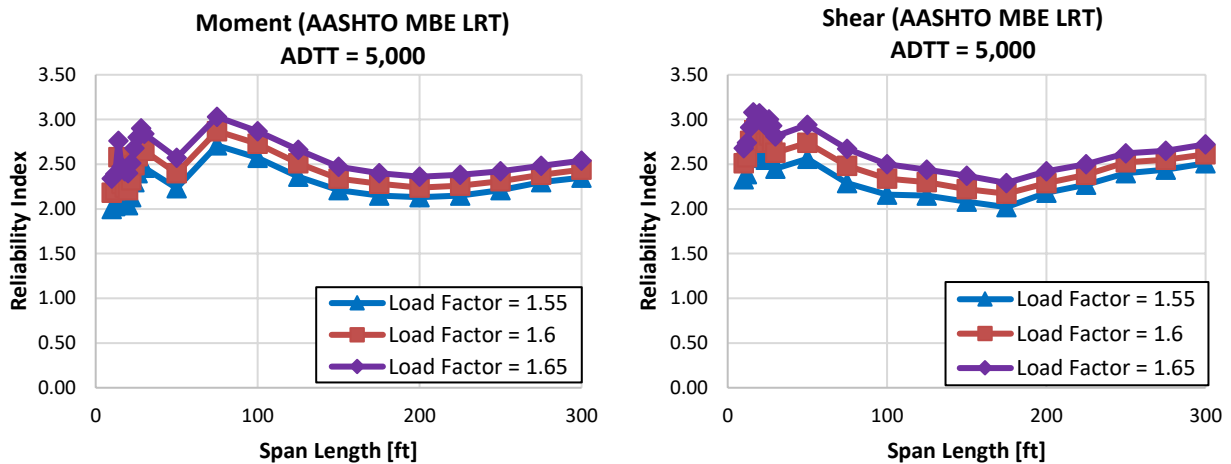


Figure 6-12: Reliability index for AASHTO MBE LRT, and ADTT = 5,000

These plots indicate that the reliability index is driven by bridges with span lengths of 150 feet or longer. That may be caused by the presence of long and heavy Alaska legal trucks. For the AASHTO MBE LRTs and an ADTT of 1,000, a live load factor of 1.50 provides consistent safety for span lengths ranging from 150 to 300 feet in flexure, and for spans between 100 to 300 feet in shear. However, the reliability index for shorter-span bridges (10 to 20 feet) resulted in a lower reliability index, possibly due to the presence of the Alaska routine permit trucks with a 25% overload allowance for single, tandem, tridem, and quad axles. The Alaska Legal Live Load Model contains vehicles with a single axle of 25 kips, tandem axles of 47.5 kip, and maximum tridem axles of 62.5 kips. A noticeable transition of the live load factor occurs for span lengths between 100 to 150 feet. This range was carefully evaluated when selecting the appropriate live load factor to ensure the minimum required level of safety. Based on the analysis, the recommended live load factor for the AASHTO MBE LRTs is 1.50 for an ADTT of 1,000 and 1.60 for an ADTT of 5,000. To maintain consistency with the current AASHTO approach, a

single live load factor is proposed for all span lengths for flexure and shear. The target reliability index is 2.50 but should not fall below 1.50. None of the governing cases yielded a reliability index lower than 1.50 for the recommended live load factors.

Figure 6-13 presents a calculated reliability index for the selected live load factors of 1.40, 1.45, and 1.50 for the AASHTO MBE SHVs, considering an ADTT of 1,000 for moment and shear. Similarly, **Figure 6-14** shows the reliability index for the live load factors of 1.55, 1.60, and 1.65, for an ADTT of 5,000 for moment and shear.

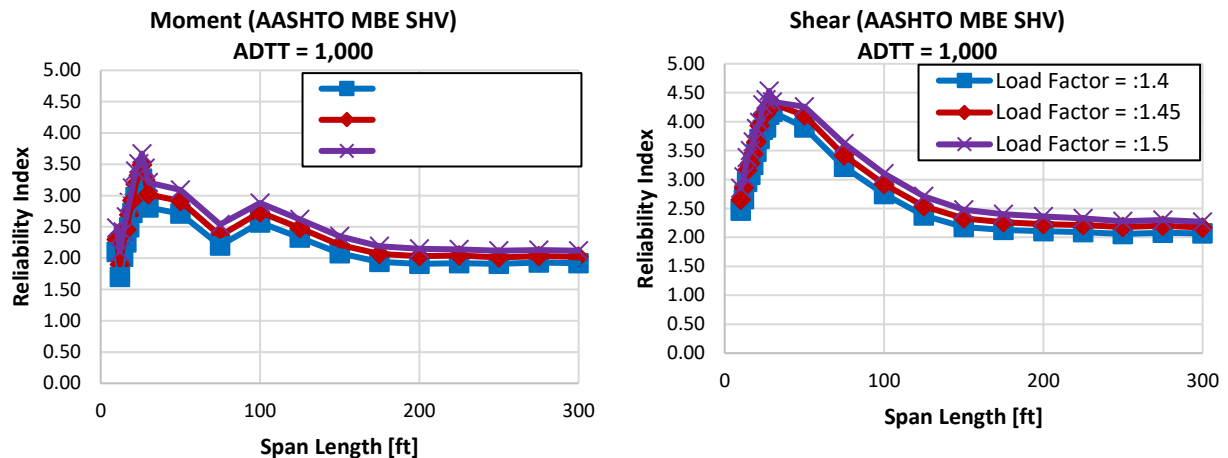


Figure 6-13: Reliability Index for AASHTO MBE SHV, and ADTT = 1,000

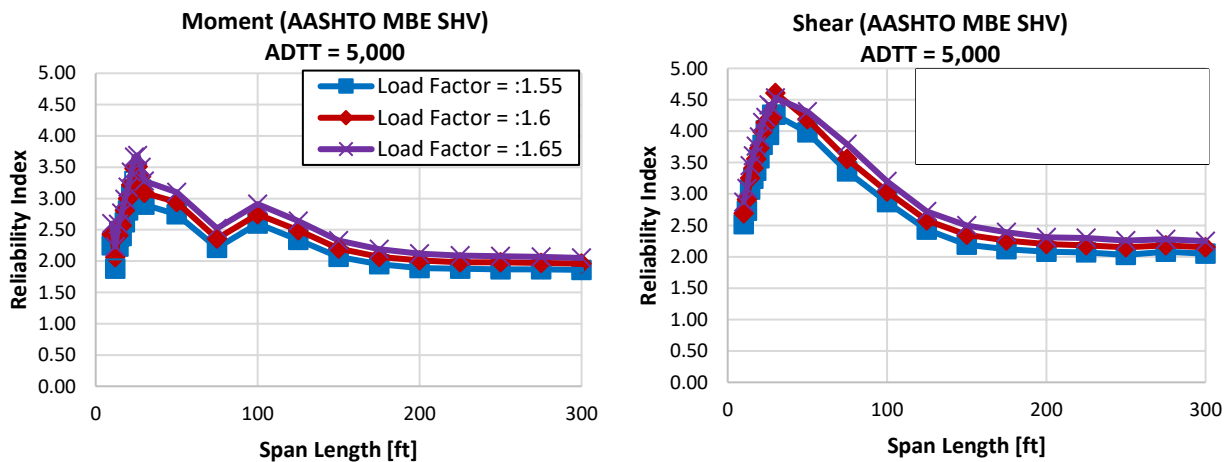


Figure 6-14: Reliability Index for AASHTO MBE SHV, and ADTT = 5,000

As discussed, the SHV model is not suitable for both short-span bridges (up to 30 feet) due to the high variability in the reliability index with a single live load factor, and for long-span bridges (over 100 feet) as it lacks the lane load model required to account for Alaska's heavy, long trucks and ensure consistent reliability. Therefore, as stated previously, the SHV model will not be used as a notional truck for evaluating Alaska legal traffic.

Chapter 7: Ore Truck Traffic in Alaska

Alaskan ore trucks are double-tractor-trailer vehicles designed for heavy-duty hauling. They are legal loads that began hauling in the summer of 2023. These specialized 16-axle trucks measure 95 feet in out-to-out length and have a maximum loaded weight of 165 kips. **Figure 7-1** illustrates the configuration of an ore truck, highlighting its unique design and load distribution. At peak operation, up to 120 ore trucks (60 fully loaded) are expected to travel daily along the Alaska/Richardson Highway corridor between Tok and Fox for an estimated 5 years. The introduction of these trucks impacts traffic by increasing overall truck volume by 40%. However, the volume of legal trucks with a GVW of at least 160 kips in the WIM data or weight station records does not reflect the expected volume of ore truck traffic. In anticipation of the increase of ore trucks traveling in Alaska, additional calibration was conducted to evaluate the impact of these trucks on bridge rating procedures.

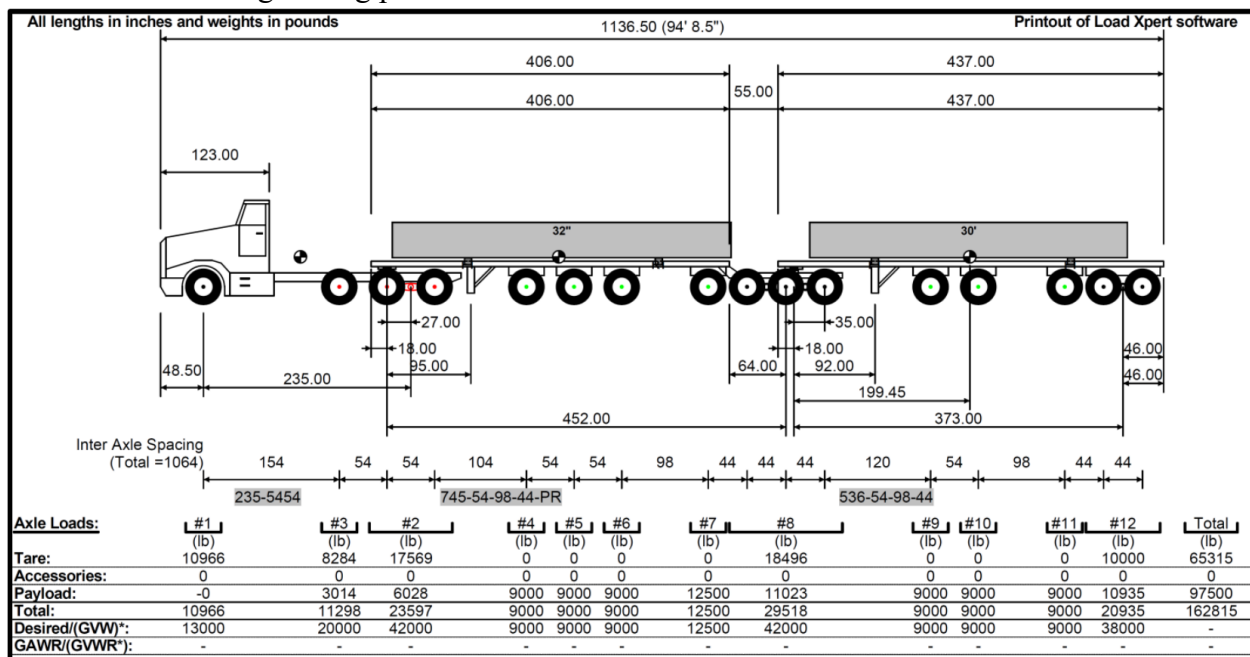


Figure 7-1: Ore truck configuration.

7.1 Ore trucks in WIM data

Alaska WIM data was used to evaluate the live load envelope and provide bridge load rating recommendations. The WIM captures trucks with up to 14 axles, limiting its ability to fully record 16-axle ore trucks. However, it does include vehicles with GVW up to 180 kips and lengths of up to 120 feet, creating greater load effects than ore trucks. For the initial study phase, WIM data from 2022 and 2023 was reviewed to estimate the number of potential ore trucks in the traffic flow. According to **Table 3-1**, the GVW of only 221 trucks exceeded 160 kips, but considering the 14-axle limitation, vehicles with a GVW over 140 kips (3,773 trucks) were also included. Based on this data, the “poa” WIM site recorded an average of six heavy trucks per day, while the Tok and Fox sites reported only one truck daily. Due to the recent increase in ore

truck traffic, 2024 WIM data was analyzed to assess the Average Daily Truck Traffic at the Fox and Tok sites. These two sites were the only ones showing increased truck traffic in 2024.

Figure 7-2 presents the WIM-based ADTT for these locations.

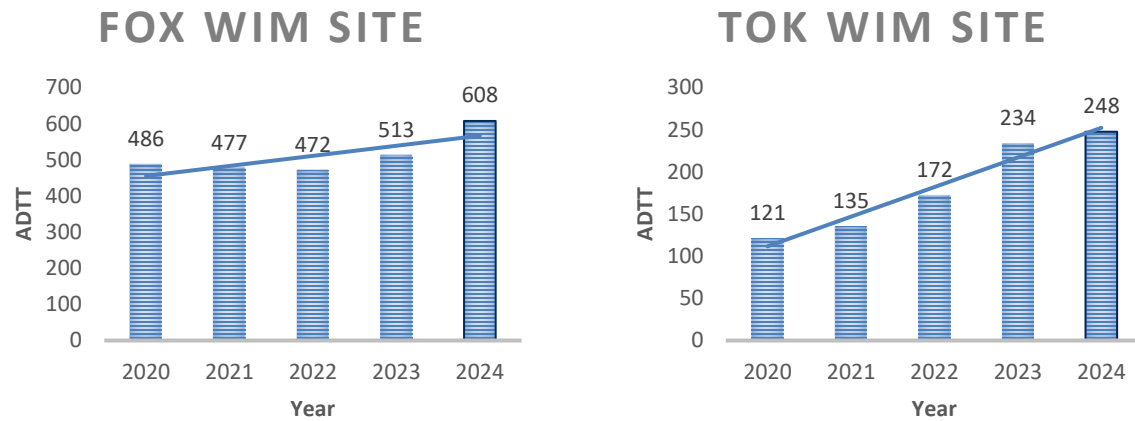


Figure 7-2: Average Daily Truck Traffic at Fox and Tok WIM sites for the years 2020-2024.

Moreover, WIM data from Fox and Tok for 2020–2024 was analyzed to estimate the number of potential ore trucks in the traffic flow. **Table 7-1** presents the number of trucks with GVWs exceeding 150 and 160 kips. While there is an increase in heavy truck traffic, the data still shows only one to two trucks per day on average, far below the expected 120 ore trucks per day.

Table 7-1: Fox and Tok WIM statistics for trucks with GVW greater than 150 kips.

WIM Site	Year	Days with WIM Records	Number of WIM Records	Computed ADTT (Col4/Col3)	Number of Records GVW > 80 kip	Number of Records GVW > 150 kip	Number of Records GVW > 160 kip	Factor to account for a full year (365/Col3)	Adjusted Full Year Records GVW > 150 kip (Col7xCol9)	Adjusted Full Year Records GVW > 160 kip (Col8xCol9)	Rounded Daily Number of Records GVW > 150 kip (Col7/Col3)
Fox	2020	355	172,588	486	12,503	147	103	1.03	151	106	1
Fox	2021	365	174,152	477	10,348	113	83	1	113	83	1
Fox	2022	361	170,241	472	14,577	53	32	1.01	54	32	1
Fox	2023	291	149,264	513	13,205	115	82	1.25	144	103	1
Fox	2024	167	101,491	608	12,429	236	126	2.19	516	275	2
Tok	2020	366	44,414	121	2,779	152	110	1	152	110	1
Tok	2021	365	49,267	135	1,753	35	26	1	35	26	1
Tok	2022	365	62,854	172	1,648	74	57	1	74	57	1
Tok	2023	365	85,367	234	2,196	99	51	1	99	51	1
Tok	2024	161	39,875	248	1,496	76	44	2.27	172	100	1

7.2 Ore Traffic Calibration

WIM data and Weigh Station records did not capture the expected volume of ore trucks; therefore, ore truck traffic was simulated to model the live load envelope. The simulation used a fixed truck configuration but varied the axle weight to reflect realistic loading conditions. The simulation input parameters were derived from Alaska Weigh Station measurements from all 255 available ore truck records. These measurements were used to establish the upper and lower bounds for axle weights. Then, these axle weight ranges were used to assign variable weights to fixed ore truck configurations in the simulation. The resulting simulated dataset included 573,737 distinct ore trucks. A random sample of 200,000 trucks from this dataset was selected to represent five years of ore truck operations. The simulated GVWs were capped at 166.5 kips, the maximum legal weight for the given configuration controlled by the Federal Bridge Formula with an additional 4,500 lbs allowance. Ore trucks exceeding 165 kips must be offloaded before continuing from the gold mines. Thus, the 166.5-kip cutoff used in the simulation is a conservative representation of legal operational limits.

The simulated ore trucks provided the basis for modeling expected ore traffic. The resulting live load envelope was compared to AASHTO MBE LRTs, and statistical parameters for ore trucks were developed following the procedure outlined in Section 6.1. **Figure 7-3** presents the ore truck bias factors for moments, and **Figure 7-4** for shears alongside previously developed bias factors using Alaska WIM data for ADTT values of 1,000 and 5,000. For short spans, ore truck bias factors were lower than those from WIM-based models. Since short-span bridges are primarily influenced by heavy axle weights, the lower bias factors in ore trucks result from their relatively lighter axle weights. For longer-span bridges, it shows that ore trucks generate higher statistical parameters than WIM trucks. This suggests that ore trucks have a greater impact on longer spans, which was further assessed in the full probabilistic analysis.

The ore truck probabilistic calibration used the developed statistical parameters and followed the reliability analysis presented in Section 6.4. **Figure 7-5** shows the calibrated live load factor for a target reliability index of 2.50 for both moment and shear, with the live load factor ranging from 1.0 to 1.65 for different span lengths and bridge material types. **Figure 7-6** presents the reliability index for a live load factor of 1.60, demonstrating that short-span bridges are unaffected by ore trucks, while long-span bridges with a live load factor of 1.60 still meet the target reliability index. This confirms that legal ore truck configurations are encompassed by the AASHTO MBE LRTs with the proposed live load factor of 1.60.

Although ore truck bias factors for long-span bridges are greater than WIM-based bias factors, the coefficient of variation is lower. The ore truck's maximum GVW is 166.5 kips and axle configurations are variable, and the force effects are primarily governed by GVW. As a result, the coefficient of variation for long-span bridges is less than 5%. The combination of the

developed statistical parameters, including bias factor and coefficient of variation, concludes that the same load factor can be used for both Alaska legal and ore truck traffic.

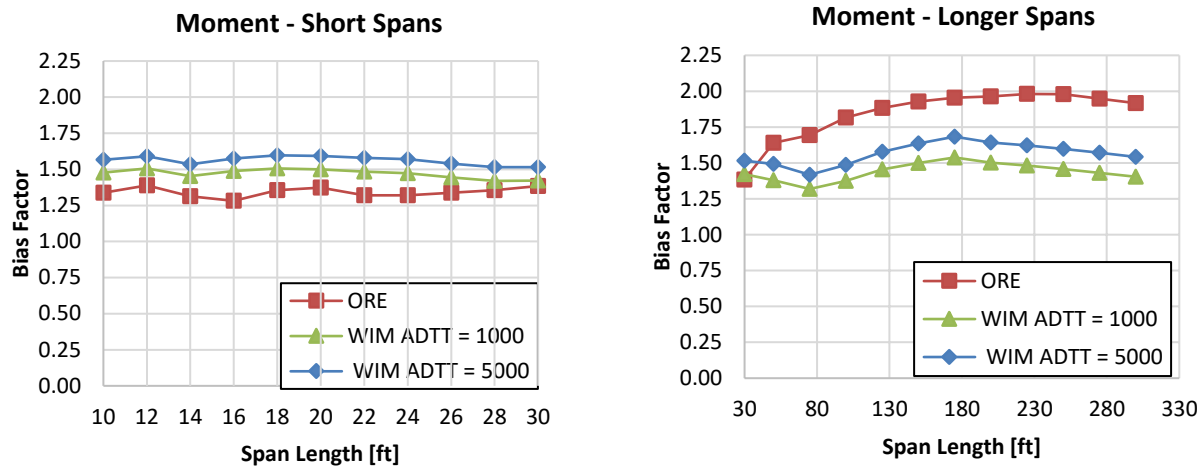


Figure 7-3: Bias factor for the Ore and WIM trucks for moment.

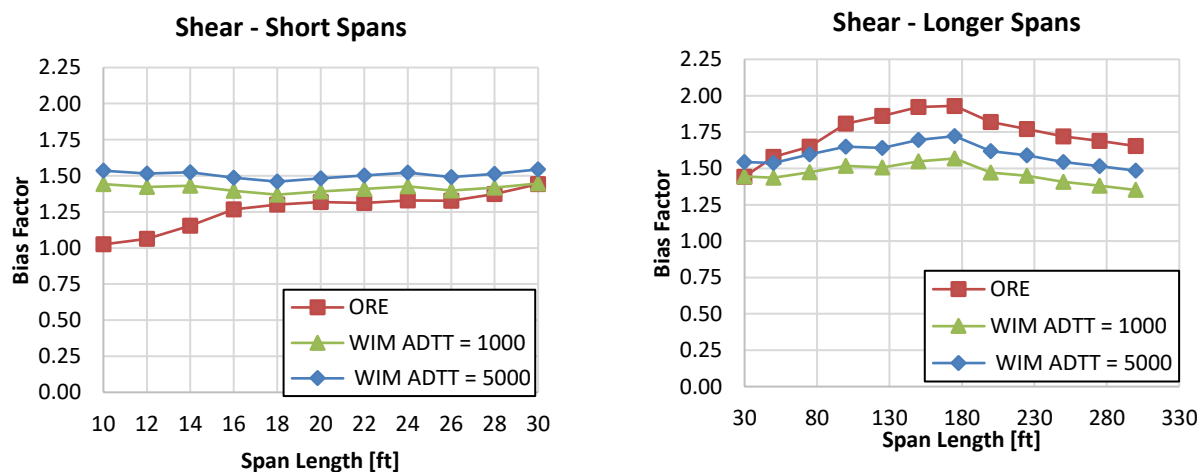


Figure 7-4: Bias factor for the Ore and WIM trucks for shear.

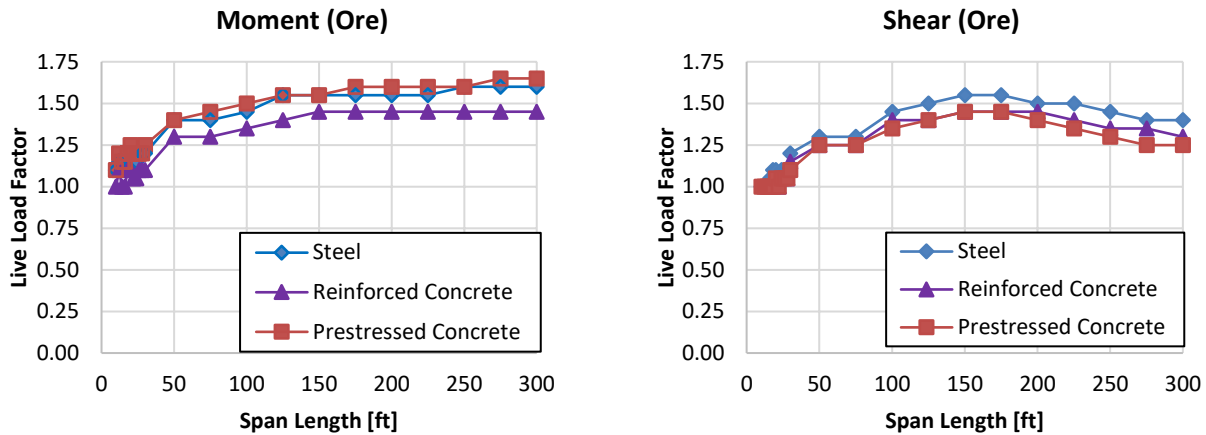


Figure 7-5: Calibrated Live Load Factors for Ore trucks

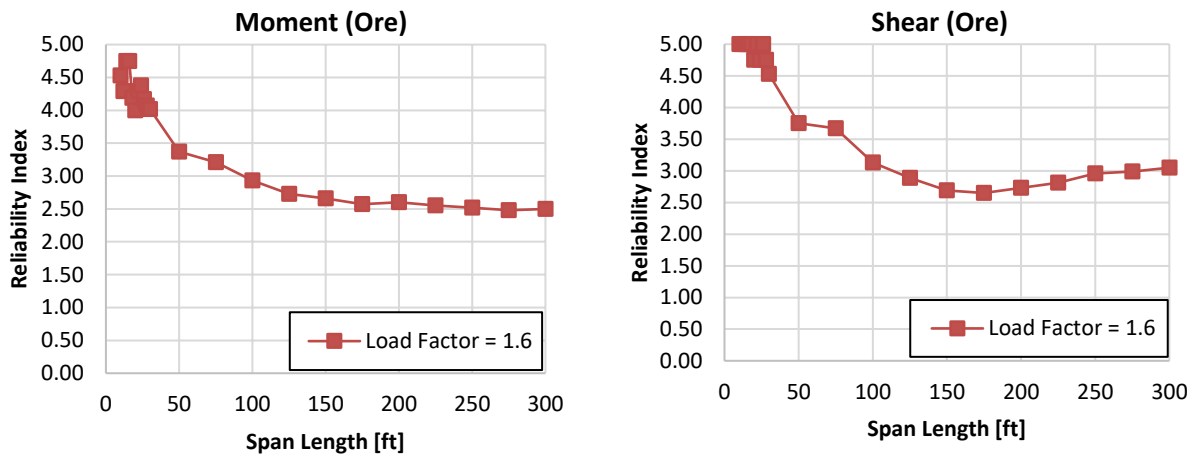


Figure 7-6: Reliability index for Ore trucks.

7.3 Long Combination Vehicle Calibration

Alaska Long Combination Vehicles (LCVs) are trucks with a wheelbase greater than 75 feet. The length of typical LCVs is between 90 and 95 feet; double and triple LCVs can be up to 95 feet and 120 feet, respectively. These vehicles can legally operate in Alaska with a GVW greater than 80 kips. Additional calibration for ore trucks was performed for the 16-axle truck configuration. To verify other LCVs, the calibration for WIM trucks with total lengths exceeding 75 feet was performed. Since LCVs represent only 5% of the total traffic volume, this proportion was incorporated into the analysis. The development of live load statistical parameters and the calibration follow the methods outlined in section 6.1.

Figure 7-7 presents the LCV bias factors, compared with the previously developed bias factors using Alaska WIM data for an ADTT of 5,000. Similar to ore trucks, LCVs exhibit lower bias factors than WIM-based models for short spans. Governed by the FBF, LCVs have lighter axle

loads, which do not control short-span bridges. For longer-span bridges, however, LCVs produce higher bias factors. Controlled by GVW.

Figure 7-8 shows the coefficient of variation for LCVs and Alaska WIM data for an ADTT of 5,000, with LCVs exhibiting much lower variation for long-span bridges, as the GVW is limited for most legal long configurations by the FBF. Full calibration of LCVs was conducted for ADTTs of 1,000 and 5,000, with LCVs accounting for 5% of the total traffic volume.

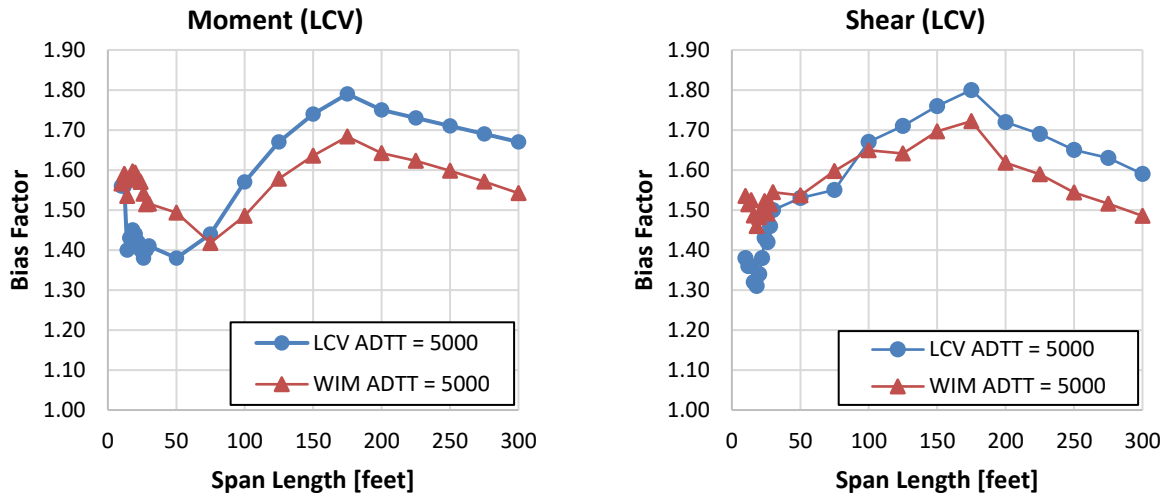


Figure 7-7: Bias factor for the LCV and WIM trucks for ADTT of 5,000.

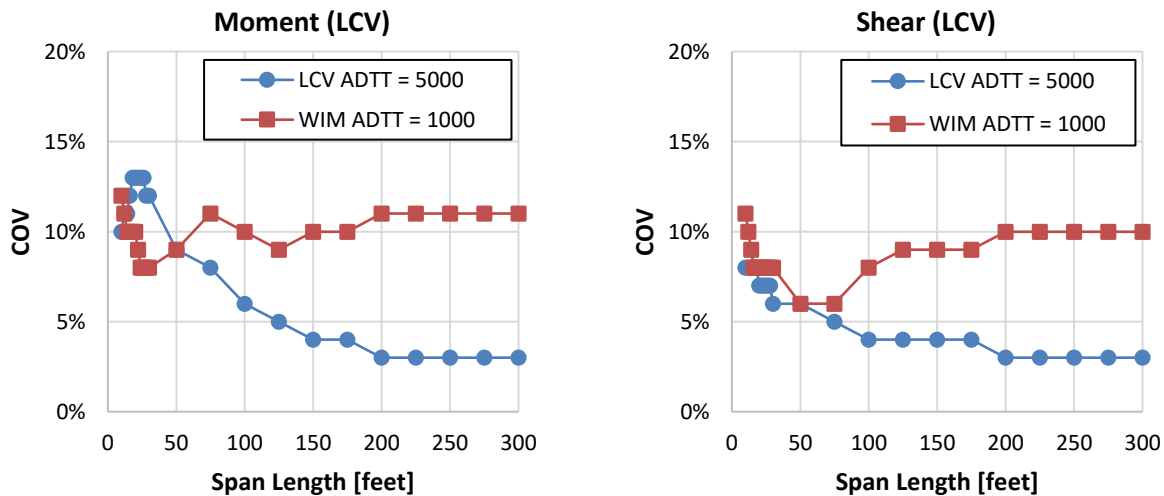


Figure 7-8: Coefficient of variation (COV) for the LCV and WIM trucks for ADTT of 5,000.

The LCV probabilistic calibration results are presented in the following figures for spans greater than 100 feet, as short spans are not impacted. **Figure 7-9** shows the reliability index for a live load factor of 1.65, demonstrating that bridges with span lengths greater than 150 feet and an ADTT of 1,000 achieve the target reliability index of 2.50. **Figure 7-10** presents the reliability index for a live load factor of 1.75, showing that bridges with span lengths greater than 150 feet

and an ADTT of 5,000 also meet the target reliability index of 2.50. To account for LCVs on long-span bridges, the live load factors should be adjusted to 1.65 for ADTT of 1,000 and to 1.75 for ADTT of 5,000 for the AASHTO LRTs.

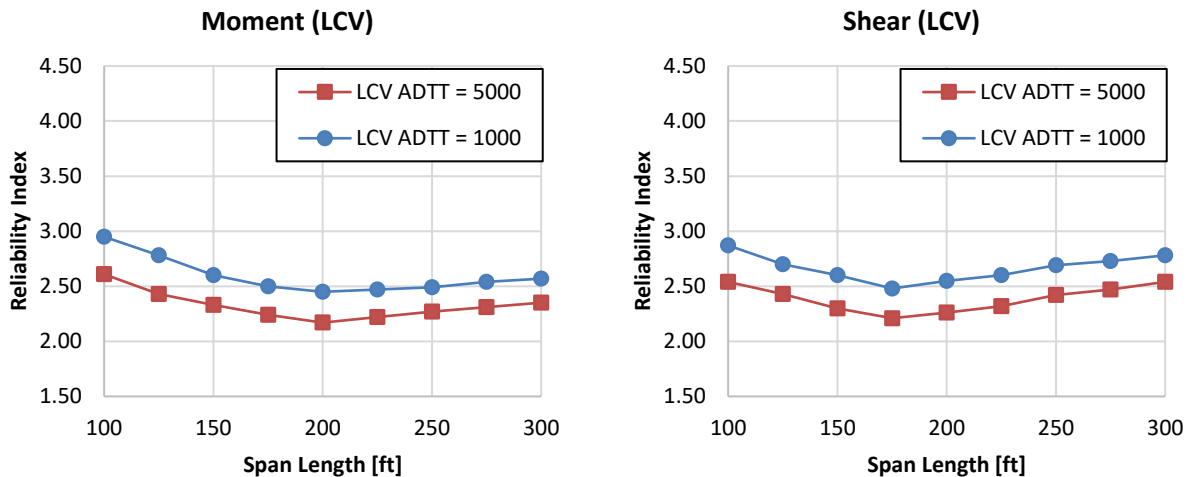


Figure 7-9: Reliability index for Long Combination Vehicles, and live load factor of 1.65.

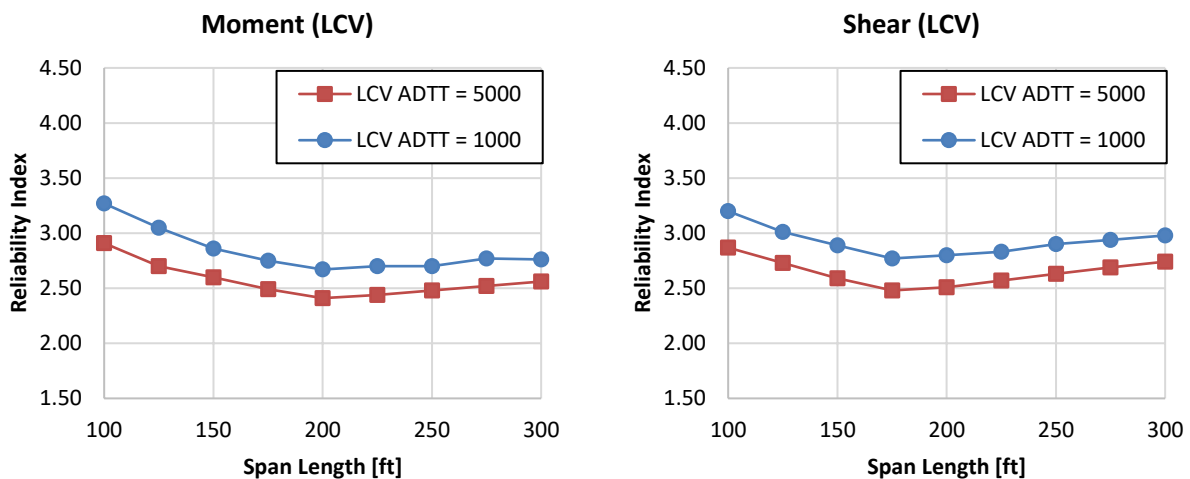


Figure 7-10: Reliability index for Long Combination Vehicles, and live load factor of 1.75.

Chapter 8: Deterministic Analysis

The Alaska Live Load model, derived from WIM data, may not account for infrequent but extreme loading events, such as fully loaded legal and routine permit trucks that do not typically appear in regular traffic patterns. Therefore, a deterministic analysis was performed to check for maximized truck configurations and extreme load cases.

The deterministic analysis evaluates the force effects of Alaska's maximum legal and routine permit trucks compared to the AASHTO MBE LRTs and design live load models, including HL-93 and HS-20 truck models. The goal is to report overstress levels caused by extreme legal and routine permit trucks in comparison to the notional trucks, with appropriate live load factors. Representative truck configurations were developed, and the weights were maximized in compliance with Alaska statutes. The resulting maximum force effects were then compared to the proposed and design live load models across various span lengths and loading scenarios. Controlling force effect ratios were identified.

8.1 Alaska Traffic Classification

To classify truck configurations, Alaska's traffic was divided into three categories: (1) Typical Trucks which include vehicles conforming to the FHWA truck classification scheme; (2) Combination Vehicles which are Alaska-specific trucks with 8 to 11 axles and wheelbase up to 75 feet; and (3) Long Combination Vehicles with wheelbase greater than 75 feet, but less than 120 feet.

A total of 64 distinct truck configurations were developed to represent maximum legal and routine permit trucks. Legal truck weights were maximized according to axle group limits: 20 kips for single axles, 38 kips for tandem axles, and 42, 43.5, and 45 kips for tridem axles with minimum axle spacings of 3.5, 5, and 6 feet, respectively. Quad axles were limited to 50 kips. The GVW was governed by the FBF, with an additional 4,500 lbs included to reflect Alaska-specific allowances; 3,000 lbs for trucks without lift axles and 1,500 lbs for snow and ice buildup. These allowances were conservatively applied to all truck configurations.

In addition to legally compliant trucks, a separate set of configurations was developed to represent routine permit traffic. These trucks were modeled with weights up to 125% of the FBF and axle group limits. In Alaska, routine permits are only issued for multi-trip, non-divisible loads and must comply with legal dimension limits: 10 feet 6 inches in width, 15 feet in height, and a maximum length of 45 feet for single trailers or 75 feet for multi-trailer combinations. Out of the 64 configurations, trucks that satisfied these dimensional criteria were incorporated into a subset and subsequently adjusted to align with the maximum permissible routine permit weights.

As a result, two sets of representative truck configurations were created: one based on legal load limits and another based on 125% of legal limits. These two sets of representative configurations

were used in the deterministic analysis to capture the full range of legal and routine permit traffic in Alaska. The representative truck configurations include vehicles ranging from 2 to 19 axles, with wheelbases up to 120 feet. Legal truck GVWs range from 40 to 193 kips, while routine permit vehicles (125% legal) range from 50 to 156 kips and are limited to 75 feet in length.

Figure 8-1 presents the wheelbase and GVW of Alaska Legal and Routine Permit Trucks.

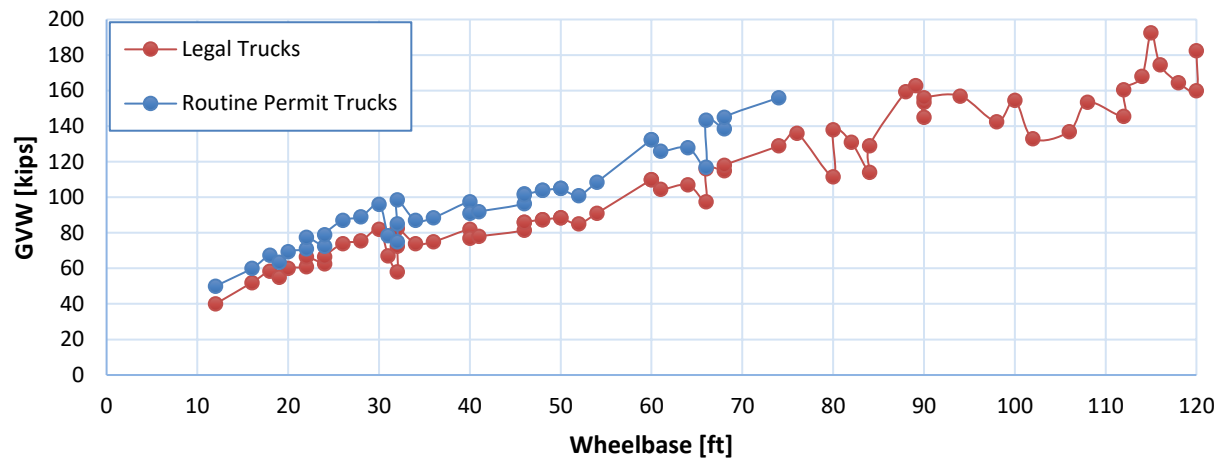


Figure 8-1: Wheelbase vs. GVW of the representative Legal and 125% Legal Alaska trucks.

A review of Alaska WIM and permit data confirms that the selected legal truck configurations adequately represent both legal and routine permit traffic. Permit records from 2019 to 2023 indicate that overweight (OW) trucks operating under routine permits do not exceed a GVW of 150 kips. Additionally, 95% of Alaska overweight and oversized (OWOS) routine permit trucks fall below 180 kips. WIM data shows that the maximum captured GVWs range from 158 to 178 kips, depending on location, with an average maximum GVW of 165 kips.

8.1.1 Typical Trucks

Typical truck traffic in the US is consistent throughout the states, with the 5-axle (Class 9) trucks being predominant in the truck traffic flow. The extensive Alaska WIM data analysis shows that 3-axle and 5-axle trucks account for more than 85% of the truck traffic in that state. Based on that data, Alaska's typical truck traffic does not differ from other parts of the US. Therefore, readily available WIM data from Alabama and Florida, and typical legal rating trucks used in Alabama, Delaware, Michigan, Pennsylvania, South Carolina, Florida, and Tennessee were utilized to determine typical legal truck configurations. Previous studies included a review of typical truck spacings, weights, and number of axles. For this study, typical truck configurations were optimized to the maximum limits allowed by Alaska statutes and then used in the deterministic analysis. For the configurations with a tridem, the variation was added to reflect Alaska tridem limits for minimum spacings of 3.5, 5, and 6 feet. A total of 24 truck configurations were developed to represent Alaska's typical truck traffic. The list of trucks is

shown in **Table 8-1**. The GVW of these typical trucks varies from 40 to 97.5 kips for legal trucks, and 50 to 117 kips for routine permit trucks. **Appendix O** presents configurations of typical legal and routine permit truck configurations.

Table 8-1: Typical Truck Configurations maximized per Alaska statutes.

ID	Candidate	Truck Type	Length [ft]	#Axles	Legal GVW [kips]	125% Legal GVW [kips]
1	Candidate 1	Single-Unit	12	2	40	50
2	Candidate 2	Single-Unit	16	3	52	60
3	Candidate 3	Combination-Vehicle	32	3	58	75
4	Candidate 4	Single-Unit	20	4	60	69.5
5	Candidate 5	Single-Unit	22	4	61	71
6	Candidate 6	Single-Unit	24	4	62.5	72.5
7	Candidate 7	Combination-Vehicle	31	4	67	78.5
8	Candidate 8	Combination-Vehicle	46	5	81.5	96.5
9	Candidate 9	Combination-Vehicle	32	5	72.5	85
10	Candidate 10	Combination-Vehicle	34	5	74	87
11	Candidate 11	Combination-Vehicle	36	5	75	88.5
12	Candidate 12	Combination-Vehicle	52	5	85	101
13	Candidate 13	Combination-Vehicle	46	6	86	102
14	Candidate 14	Single-Unit	48	6	87.5	104
15	Candidate 15	Combination-Vehicle	50	6	88.5	105
16	Candidate 16	Combination-Vehicle	46	6	86	101.5
17	Candidate 17	Combination-Vehicle	48	6	87.5	104
18	Candidate 18	Combination-Vehicle	50	6	88.5	105
19	Candidate 19	Combination-Vehicle	40	6	82	97.5
20	Candidate 20	Combination-Vehicle	66	6	97.5	117
21	Candidate 21	Combination-Vehicle	40	5	77	91
22	Candidate 22	Combination-Vehicle	24	5	66.5	79
23	Candidate 23	Single-Unit	28	6	75.5	89
24	Candidate 24	Single-Unit	32	7	82.5	98.5

Also, the AASHTO MBE legal truck configurations were maximized to meet Alaska statutes and utilized for the deterministic analysis. Most legal trucks are governed by the FBF, resulting in a 10% increase for legal and 25% for routine permit traffic. **Table 8-2** presents the AASHTO MBE Legal Truck Configurations maximized per Alaska statutes.

Table 8-2: AASHTO MBE Legal Truck Configurations Maximized per Alaska statutes.

ID	Candidate	Truck Type	Length [ft]	#Axles	Legal GVW [kips]	125% Legal GVW [kips]
25	Candidate 25	Single-Unit	19	3	55	63.5
26	Candidate 26	Combination-Vehicle	41	5	78	92
27	Candidate 27	Combination-Vehicle	54	6	91	108.5
28	Candidate 28	Single-Unit	18	4	58.5	67.5
29	Candidate 29	Single-Unit	22	5	66.5	77.5
30	Candidate 30	Single-Unit	26	6	74	87
31	Candidate 31	Single-Unit	30	7	82	96

8.1.2 Alaska Combination and Long Combination Vehicles

To identify Alaska-specific truck configurations, the Alaska WIM dataset of 1.2 million legal and routine permit traffic records was analyzed, focusing on trucks with more than seven axles. The key characteristics of these vehicles were captured. Details on GVW, axle count, and individual axle weights and spacings are provided in **Appendix N**. The WIM data provided insights into typical configurations, and a separate filtering and review process was used to select the relevant trucks.

Trucks were categorized as Combination Vehicles if their wheelbase did not exceed 75 feet and as Long Combination Vehicles (LCVs) if their length was greater than 75 feet but not exceeding 120 feet. Typical configurations with 8 to 14 axles were identified directly from the WIM data. Due to sensor limitations (the sensors used in Alaska WIM sites only record truck characteristics for up to 14 axles), 15- and 16-axle LCVs were developed using the ore truck configuration as a representative model.

Several A-train configurations were initially considered by the State for transporting ore, but ultimately were not approved and are currently not used within Alaska. These configurations included an A-train with a 90-foot wheelbase and 153.5 kips GVW, a B-train with a 90-foot wheelbase and 156 kips GVW, and a very long A-train with a 118-foot wheelbase and 19 axles, with a GVW of 193 kips. The deterministic analysis initially included truck configurations with up to 16 axles to capture the range of legal and routine permit traffic. The FBF provides GVW limits for trucks with up to 9 axles, which covers most legal configurations. Routine permit trucks, which must operate without escorts and navigate standard roadways, typically range from 9 to 13 axles. The decision to include up to 16 axles was made to incorporate the ore truck configuration now operating in Alaska. Trucks with more than 16 axles, such as the 19-axle A-train, do not represent legal or routine permit traffic. These extremely long and heavy vehicles operate under different conditions, including reduced speeds, which affect the dynamic allowance factors. Nevertheless, the three train configurations were included in the deterministic analysis for reference (Candidates 62-64). Based on Alaska's legal and routine permit limits, typical truck configurations can weigh up to 155 kips, while LCVs with up to 16 axles can weigh up to 180 kips. All such configurations were included in the legal deterministic analysis.

Table 8-3 summarizes the maximized Alaska Combination and Long Combination Vehicles, with GVWs ranging from 107 to 193 kips. Additional details on these configurations are provided in **Appendix Q**.

Table 8-3: Combination and Long Combination Vehicle Configurations Maximized per Alaska statutes.

ID	Candidate	Truck Type	Length [ft]	#Axles	Legal GVW [kips]	125% Legal GVW [kips]
33	Candidate 33	AK-Combination-Vehicle	64	8	107	128
34	Candidate 34	AK- Long Combination Vehicle	80	8	111.5	N/A
35	Candidate 35	AK- Long Combination Vehicle	84	8	114	N/A
36	Candidate 36	AK-Combination-Vehicle	60	9	110	132.5
37	Candidate 37	AK-Combination-Vehicle	60	9	110	132.5
38	Candidate 38	AK-Combination-Vehicle	68	9	115	138.5
39	Candidate 39	AK- Long Combination Vehicle	102	9	133	N/A
40	Candidate 40	AK-Combination-Vehicle	66	10	116	143.5
41	Candidate 41	AK-Combination-Vehicle	68	10	118	145
42	Candidate 42	AK- Long Combination Vehicle	84	10	129	N/A
43	Candidate 43	AK- Long Combination Vehicle	106	10	137	N/A
44	Candidate 44	AK-Combination-Vehicle	74	11	129	156
45	Candidate 45	AK- Long Combination Vehicle	82	11	131	N/A
46	Candidate 46	AK- Long Combination Vehicle	98	11	142.5	N/A
47	Candidate 47	AK- Long Combination Vehicle	112	11	145.5	N/A
48	Candidate 48	AK- Long Combination Vehicle	76	12	136	N/A
49	Candidate 49	AK- Long Combination Vehicle	80	12	138	N/A
50	Candidate 50	AK- Long Combination Vehicle	108	12	153.5	N/A
51	Candidate 51	AK- Long Combination Vehicle	120	12	160	N/A
52	Candidate 52	AK- Long Combination Vehicle	90	13	145	N/A
53	Candidate 53	AK- Long Combination Vehicle	100	13	154.5	N/A
54	Candidate 54	AK- Long Combination Vehicle	112	13	160.5	N/A
55	Candidate 55	AK- Long Combination Vehicle	118	13	164.5	N/A
56	Candidate 56	AK- Long Combination Vehicle	94	14	157	N/A
57	Candidate 57	AK- Long Combination Vehicle	114	14	168	N/A
58	Candidate 58	AK- Long Combination Vehicle	88	15	159.5	N/A
59	Candidate 59	AK- Long Combination Vehicle	116	15	174.5	N/A
60	Candidate 60	AK- Long Combination Vehicle	89.1	16	162.8	N/A
61	Candidate 61	AK- Long Combination Vehicle	120	16	182.5	N/A
62	Candidate 62	AK- Long Combination Vehicle	90	14	153.5	N/A
63	Candidate 63	AK- Long Combination Vehicle	90	15	156	N/A
64	Candidate 64	AK- Long Combination Vehicle	115	19	192.5	N/A

8.2 Force Effects Ratios

The Alaska representative truck candidates' configurations were evaluated using influence line analysis across span lengths ranging from 10 to 500 feet for the nine load cases defined in Chapter 5. The force effects of these Alaska-maximized trucks were then compared to the proposed live load model, which includes AASHTO MBE LRTs, as well as AASHTO design live load models. The legal force effect ratio is calculated as follows:

$$\text{Legal Force Effect Ratio} = \frac{LLF_c \times \text{Alaska Max Truck} \times IM}{LLF \times \text{AASHTO LRT} \times IM}$$

where:

LLF_c – Live Load Factor for Alaska Truck Candidates (assumed 1.30)

Alaska Max Truck – Maximum force effect caused by Alaska legal and routine permit truck candidates

IM – Dynamic Impact Factor based on the LFR equation

LLF – Live Load Factor for AASHTO LRTs (1.60 for Typical Trucks, and 1.75 for Long Combination Vehicles)

AASHTO LRT – Maximum force effect caused by AASHTO Legal Rating Trucks (LRTs)

Determining the dynamic load effect of a vehicle on a structure is complex due to variables like bridge frequency, span length, type and geometry, roadway surface, vehicle weight, speed, number of axles, and suspension type. Thus, a single conservative value of dynamic load allowance was established to simplify the application. The design impact factor (IM) specified by AASHTO LRFD is 1.33, while the AASHTO Standard Specifications use the following equation that relates the IM to span length, $1 + 50 / (\text{span length} + 125)$, with a maximum value of 1.30. The design provisions are conservative, but a more accurate dynamic response of bridges was desired for this evaluation. Field testing has shown that most bridges do not experience impact effects greater than 1.25 (AASHTO LRFD C3.6.2.1). The AASHTO MBE allows for further reduction of the IM to 1.10 for smooth road surfaces and 1.20 for rough surfaces, as shown in Table C6A.4.4.3-1.

For the deterministic analysis, an IM based on the LFR equation was applied to AASHTO LRTs and Alaska truck candidates. Alaska LCVs have higher GVW and more axles than standard rating trucks, and typically only govern longer-span bridges (over 150 feet), where a reduced IM is considered appropriate. Nonetheless, the LFR impact based on the equation was conservatively included for all Alaska truck candidates.

The LLF for Alaska truck candidates was selected based on the LFR recommendation for legal trucks, which specifies an LLF of 1.30. This value is conservative, as truck configurations are already maximized under Alaska statutes for both legal and routine permit weight limits. Consequently, applying an LLF of 1.30 produces ratios greater than one. Therefore, it is included only as a reference and does not influence the recommendations of this study. The LLFs for Alaska legal and routine permit traffic are based on the calibration effort, where LLF of 1.60 is used to represent Alaska typical trucks, and 1.75 for LCVs.

Next, the force effects of these Alaska-maximized trucks were then compared to AASHTO design live models, including HS-20 (LFR) and HL-93 (LRFR). The design force effect ratio is calculated as follows:

$$\text{Design Force Effect Ratio} = \frac{LLF_c \times \text{Alaska Max Truck} \times IM}{LLF \times \text{AASHTO INV} \times IM}$$

where:

LLF_c – Live Load Factor for Alaska Truck Candidates (assumed 1.30)

Alaska Max Truck – Maximum force effect caused by Alaska legal and routine permit truck candidates

IM – Dynamic Impact Factor (LFR based on the equation, and 1.33 for LRFR)

LLF – Live Load Factor (2.17 for HS-20, and 1.75 for HL-93)

AASHTO INV – Maximum force effect caused by AASHTO design trucks at inventory level

The design IM was used in the force effect equation, where IM for HS-20 was computed using the AASHTO Standard Specifications equation, with factors ranging from 1.08 to 1.30 depending on span length. Design IM of 1.33 was applied to the HL-93. Alaska truck candidates used the design IM calculated from the equation for HS-20, and 1.33 for HL-93. Force effects were computed for all truck configurations, span lengths, and load cases. The maximum controlling ratios are presented in the following subchapters.

8.2.1 Legal Traffic

Maximized Alaska legal trucks were developed to represent the legal live load envelope. The maximum controlling ratios for Alaska Typical Legal trucks are presented in **Table 8-4**. The table presents the span length, maximum ratio, the controlling truck type with GVW, and the load case. The deterministic analysis shows that the force effects of factored maximum typical truck candidates exceed factored AASHTO MBE LRTs. The controlling force effect ratios range from 1.03 to 1.82. The maximum controlling ratios for LCVs are presented in

Table 8-5. The analysis also shows that Alaska LCVs force effects exceed the AASHTO LRTs. The ratios range from 1.12 to 1.92.

Table 8-4: Force Effect Ratios for Alaska Legal Typical Vehicles to LRTs with LLF = 1.60

Span [ft]	Max Ratio	Truck	GVW [kips]	Load Case
10	1.53	Truck 30	74	M22
12	1.45	Truck 30	74	M32
14	1.36	Truck 2	52	M32
16	1.35	Truck 31	82	S2
18	1.38	Truck 31	82	S2
20	1.41	Truck 31	82	S2
22	1.43	Truck 30	74	M11
24	1.47	Truck 30	74	M11
26	1.51	Truck 31	82	M11
28	1.55	Truck 31	82	M11
30	1.59	Truck 31	82	M11
50	1.82	Truck 31	82	M33
75	1.62	Truck 31	82	M33
100	1.39	Truck 31	82	M33
125	1.24	Truck 44	129	M22
150	1.26	Truck 44	129	M22
175	1.28	Truck 44	129	M22
200	1.14	Truck 44	129	M33
225	1.08	Truck 44	129	M33
250	1.04	Truck 44	129	M33
275	1.03	Truck 44	129	S1
300	1.03	Truck 44	129	S1
400	1.04	Truck 44	129	S1
500	1.04	Truck 44	129	S1

Table 8-5: Force Effect Ratios for Alaska Legal LCVs to LRTs with LLF = 1.75

Span [ft]	Max Ratio	Truck	GVW [kips]	Load Case
10	1.24	Truck 52	145	M22
12	1.27	Truck 47	146	M22
14	1.25	Truck 63	156	S2
16	1.12	Truck 47	146	M22
18	1.20	Truck 54	161	S2
20	1.20	Truck 55	165	M22
22	1.27	Truck 55	165	M22
24	1.25	Truck 55	165	M22
26	1.17	Truck 55	165	M22
28	1.20	Truck 35	114	S2
30	1.15	Truck 63	156	M22
50	1.47	Truck 56	157	M22
75	1.92	Truck 57	168	M22
100	1.80	Truck 57	168	M32
125	1.54	Truck 57	168	M32
150	1.64	Truck 64	193	M22
175	1.72	Truck 64	193	M22
200	1.33	Truck 64	193	S1
225	1.35	Truck 64	193	S1
250	1.37	Truck 64	193	S1
275	1.39	Truck 64	193	S1
300	1.40	Truck 64	193	S1
400	1.45	Truck 64	193	S1
500	1.47	Truck 64	193	S1

8.2.2 Routine Permit Traffic

Maximized Alaska routine permit trucks, developed with a 25% overload allowance, were used to represent the upper bound of legal live load demands. The controlling force effect ratios for maximized routine permit trucks are presented in **Table 8-6**. The deterministic analysis indicates that these maximized routine permit configurations exceed the AASHTO LRTs. The maximum ratios range from 1.25 to 2.03.

Table 8-6: Force Effect Ratios for Alaska Routine Permit Trucks to LRTs with LLF = 1.60

Span [ft]	Max Ratio	Truck	GVW [kip]	Load Case
10	1.76	Truck 30	87	M22
12	1.67	Truck 30	87	M32
14	1.51	Truck 19	98	M32
16	1.53	Truck 30	87	S2
18	1.57	Truck 30	87	S2
20	1.60	Truck 30	87	S2
22	1.64	Truck 30	87	M11
24	1.68	Truck 30	87	M11
26	1.72	Truck 30	87	M11
28	1.75	Truck 30	87	M11
30	1.78	Truck 30	87	M11
50	2.03	Truck 30	87	M33
75	1.81	Truck 31	96	M33
100	1.57	Truck 31	96	M33
125	1.50	Truck 44	156	M22

Table 8-6: (continued)

Span [ft]	Max Ratio	Truck	GVW [kip]	Load Case
150	1.52	Truck 44	156	M22
175	1.54	Truck 44	156	M22
200	1.37	Truck 44	156	M33
225	1.31	Truck 44	156	M33
250	1.25	Truck 44	156	M33
275	1.25	Truck 44	156	S1
300	1.25	Truck 44	156	S1
400	1.26	Truck 44	156	S1
500	1.26	Truck 44	156	S1

8.2.3. Design Trucks

Force effects from the Alaska maximized LCVs, and routine permit trucks, were compared to the design truck force effects at the inventory level. **Table 8-7** presents the controlling force effect ratios for both design load models. Results show that force effects from the Alaska legal and routine permit trucks exceed the HS-20 for spans from 125 to 300 feet, and controlling ratios range from 0.60 to 1.20. However, force effects from the HL-93 encompass all Alaska truck candidates with controlling load ratios ranging from 0.66 to 0.97.

Table 8-7: Force Effect Ratios for Alaska Legal Vehicles compared to Inventory Design Trucks.

Span [ft]	HS-20 Inventory Level				HL-93 Inventory Level			
	Max ratio	Truck	GVW [kips]	Case	Ratio	Truck	GVW [kips]	Case
10	0.65	Truck 30	87	M32	0.74	Truck 30	87	M32
12	0.61	Truck 30	87	M32	0.67	Truck 30	87	M32
14	0.60	Truck 28	68	M11	0.66	Truck 28	68	M11
16	0.61	Truck 28	68	M11	0.67	Truck 30	87	M31
18	0.65	Truck 30	87	M11	0.70	Truck 30	87	M11
20	0.68	Truck 30	87	M11	0.72	Truck 30	87	M11
22	0.70	Truck 30	87	M11	0.74	Truck 30	87	M11
24	0.72	Truck 30	87	M11	0.76	Truck 30	87	M11
26	0.74	Truck 30	87	M11	0.77	Truck 30	87	M11
28	0.80	Truck 32	126	M22	0.78	Truck 32	126	M22
30	0.84	Truck 32	126	M22	0.81	Truck 32	126	M22
50	0.89	Truck 38	139	M22	0.87	Truck 32	126	M32
75	0.87	Truck 37	133	S2	0.81	Truck 40	139	S1
100	1.00	Truck 44	156	S2	0.86	Truck 40	139	M31
125	1.01	Truck 44	156	M11	0.90	Truck 44	156	M31
150	1.07	Truck 64	193	M11	0.93	Truck 64	193	M31
175	1.12	Truck 64	193	M31	0.96	Truck 64	193	M31
200	1.18	Truck 64	193	M31	0.97	Truck 64	193	M31
225	1.20	Truck 64	193	M31	0.97	Truck 64	193	M31
250	1.16	Truck 64	193	M31	0.97	Truck 64	193	M31
275	1.11	Truck 64	193	M31	0.96	Truck 64	193	M31
300	1.06	Truck 64	193	M31	0.94	Truck 64	193	M31
400	0.90	Truck 64	193	M31	0.88	Truck 64	193	M31
500	0.77	Truck 64	193	M31	0.81	Truck 64	193	M31

Chapter 9: Bridge Rating Recommendations

The objective of this study was to calibrate live load factors that provide consistent safety and develop new scale factors for the existing AASHTO MBE trucks to encompass Alaska Legal and Routine Permit traffic at the operating level. The recommended live load factors and corresponding scale factors were developed for Load and Resistance Factor Rating (LRFR), Load Factor Rating (LFR), and Allowable Stress Rating (ASR) methods.

A WIM-based live load model was developed to represent Alaska traffic. The AASHTO MBE LRTs were found to be suitable to represent Alaska Legal and Routine Permit traffic. Probabilistic calibration established increased live load factors for AASHTO MBE LTRs considering variable ADTT as outlined in the AASHTO MBE. Deterministic analysis confirmed that the calibrated live load factors effectively encompass maximum typical legal and routine permit trucks. However, for bridges with spans exceeding 150 feet, a higher live load factor is necessary to properly account for Alaska LCVs. Additionally, probabilistic calibration was conducted to assess the impact of ore trucks and LCVs. The calibration established increased live load factors for Alaska LCVs. Summary tables detailing the recommended factors for LRFR, LFR, and ASR are provided in this chapter.

The scale factor, which is the ratio of the recommended live load factor to the current AASHTO MBE live load factor, can be utilized to re-rate the Alaska bridge inventory for legal traffic utilizing existing operating rating factors. Additional details on applying the new live load or scale factors can be found in Chapter 10.

9.1 Load and Resistance Factor Rating

Table 9-1 presents the current AASHTO MBE live load factors at the operating level for LRTs and recommended Live Load Factors (LLF) at the operating level for Alaska typical traffic and LCVs with the corresponding scale factors.

Table 9-1: Recommended Live Load and Scale Factors for LRFR at Operating Level.

ADTT	Current AASHTO MBE LLF (Opr)	Typical Vehicles (all spans)		LCVs (span < 150 feet)		LCVs (span ≥ 150 feet)	
		Rec. LLF (Opr)	Corr. Scale Factor	Rec. LLF (Opr)	Corr. Scale Factor	Rec. LLF (Opr)	Corr. Scale Factor
Col 1	Col 2	Col 3	Col 3 / Col 2	Col 4	Col 4 / Col 2	Col 5	Col 5 / Col 2
1000	1.30	1.50	1.15	1.50	1.15	1.65	1.27
5000	1.45	1.60	1.10	1.60	1.10	1.75	1.21

9.2 Load Factor Rating

AASHTO LFD was not developed through probabilistic calibration; however, the AASHTO LRFD for an ADTT of 5,000 used the AASHTO LFD as a reference to determine the level of safety in terms of a reliability index. Therefore, the calibrated live load factors for an ADTT of 5,000 will be applied in the LFR evaluation. **Table 9-2** presents the current LFR live load factors at the operating level, the recommended live load factors at the operating level, and the corresponding scale factors for Alaska's typical traffic and LCVs.

Table 9-2: Recommended Live Load and Scale Factors for LFR at Operating Level.

Current AASHTO MBE LLF (Opr)	Typical Vehicles (all spans)		LCVs (span < 150 feet)		LCVs (span ≥ 150 feet)	
	Rec. LLF (Opr)	Corr. Scale Factor	Rec. LLF (Opr)	Corr. Scale Factor	Rec. LLF (Opr)	Corr. Scale Factor
Col 1	Col 2	Col 2 / Col 1	Col 3	Col 3 / Col 1	Col 4	Col 4 / Col 1
1.30	1.60	1.23	1.60	1.23	1.75	1.35

9.3 Allowable Stress Rating

Alaska uses the ASR method for timber bridge evaluation; therefore, provisions for this rating method were also needed. However, it is difficult to develop a rigorous approach for ASR, as it is uncalibrated and based on historical practice, not probability. One approach would be to utilize the same scale factor of 1.23 for ASR as proposed for LFR. This recommendation is based on the following:

- Neither ASR nor LFR were developed through probabilistic calibration and do not account for the uncertainty in the load and resistance variables. A scale factor acceptable for LFR could also be reasonably expected to be appropriate for ASR.
- LRFR and LFR were calibrated for an ADTT of 5,000. Since timber bridges in Alaska experience lower traffic volumes, the recommended scale factor would encompass the traffic conditions on Alaska timber structures.

Given this reasoning, a comparative calculation of rating factors computed using the LFR and ASR methods was performed. **Figure 9-1** presents some characteristics of Alaska timber bridges. There are 77 timber bridges in Alaska, mostly single span, with maximum span lengths ranging from about 30 to 100 feet. Therefore, three representative span lengths of 30, 50, and 100 feet were considered for comparative analysis.

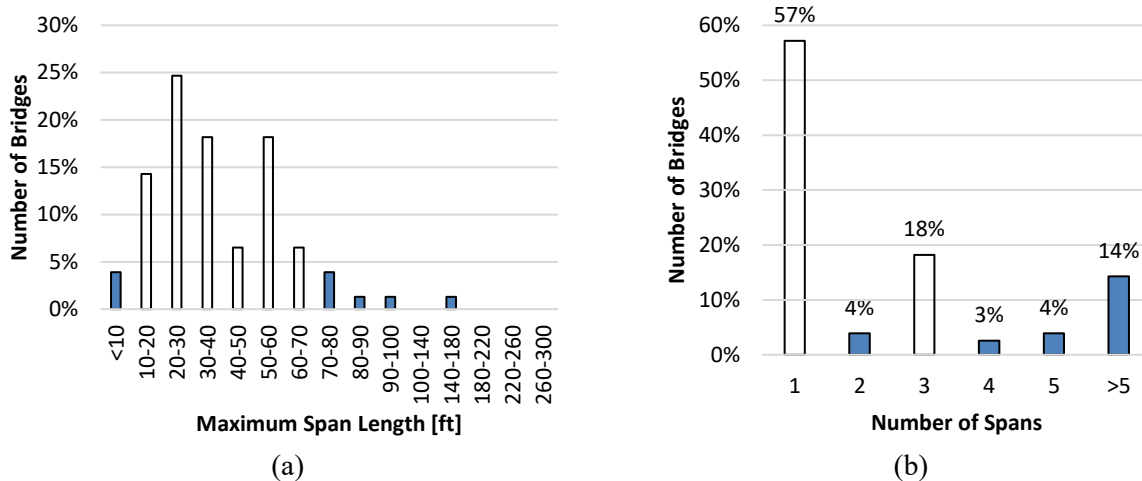


Figure 9-1: Alaska timber bridge characteristics.

The comparative analysis uses a simple-span bridge example to evaluate the maximum mid-span moment and end shear live load effects for the specified span lengths, considering the HS-20, Type 3, Type 3S2, and Type 3-3 trucks. Dead load is computed based on the typical dead load to live load (D/L) ratios developed for the representative AASHTOWare BrR database described in Section 6.2 for the selected timber span lengths. The D/L ratios of 0.50, 0.60, and 0.80 were used for span lengths of 30, 50, and 100 feet. These represent average ratios for the selected span lengths. Resistance was computed as a minimum based on the design demands for HS-20 loading. The rating factor equation used for the LFR method is as follows:

$$RF_{LFR-OPR} = \frac{R - A_1 FE_{DC}}{A_2 FE_{LL+IM}}$$

where:

$RF_{LFR-OPR}$ – rating factor for LFR at the operating level

R – resistance

FE_{DC} – force effects due to dead load

FE_{LL+IM} – force effects due to live load with a dynamic allowance

A_1 – dead load factor

A_2 – live load factor

The rating factor equation for the ASR method is:

$$RF_{ASR-OPR} = \frac{A_o R - S_{DC}}{S_{LL+IM}}$$

where:

$RF_{ASR-OPR}$ – rating factor for ASR at the operating level

A_o – factor for operating stress

R – resistance

S_{DC} – stress effects due to dead load

S_{LL+IM} – stress effects due to live load with a dynamic allowance

Sample calculations of RFs for LFR and ASR timber bridges were performed, and it was concluded that a scale factor of 1.23 is appropriate for the ASR method (**Table 9-3**).

Table 9-3: Recommended Scale Factors for ASR.

Current AASHTO MBE LLF (Opr.)	Typical Vehicles & LCVs (all spans)	
	Recommended LLF (Opr.)	Corresponding Scale Factor
N/A	N/A	1.23

Table 9-4 presents the LFR rating calculations for sample timber bridges, while **Table 9-5** shows the ASR factors. LFR uses a live load factor of 1.60, while ASR applies a scale factor of 1.23, as it does not utilize live load factors. A comparative analysis was conducted for various scale factors, including 1.23, 1.15, and 1.10, based on LRFR and LFR scale factor recommendations. The ratio of the ASR to LFR Rating Factors is presented in **Table 9-6**. The ratios using a scale factor of 1.23 range from 0.90 to 0.96, indicating that the 1.23 scale factor is appropriate for the ASR method. The scale factor of 1.15 also produces ratios below unity, making it suitable for use. However, a scale factor of 1.10 yields ratios exceeding unity, which is not recommended. If the load rating of a timber bridge utilizing a scale factor of 1.23 results in a rating factor of less than 1.0, the scale factor could potentially be adjusted to 1.15. **Table 9-6** provides guidance for refining the scale factor selection, if necessary. The recommended scale factor is 1.23.

Table 9-4: LFR calculations for sample timber bridges.

Trucks	Weight [kips]	Live Load Effects Moment - M [kip-ft], and Shear - S [kips]							Dead Load Effects (Dead Load to Live Load Ratios of 0.5, 0.6, and 0.8 are used)						Capacity						Rating Factor					
									0.5	0.5	0.6	0.6	0.8	0.8	1.0	1.0	1.0	1.0	1.0	1.0						
		M	S	M	S	M	S	γ_{LL}	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S
		30	30	50	50	100	100	-	30	30	50	50	100	100	30	30	50	50	100	100	30	30	50	50	100	100
HS-20	72	406	60	797	67	1858	69	2.17	203	30	478	40	1486	55	1145	169	2351	198	5964	221	1.00	1.00	1.00	1.00	1.00	1.00
Type 3	50	265	36	565	43	1315	50	1.60	203	30	478	40	1486	55	1145	169	2351	198	5964	221	2.08	2.26	1.91	2.11	1.92	1.86
Type 3S2	72	266	35	516	48	1586	62	1.60	203	30	478	40	1486	55	1145	169	2351	198	5964	221	2.07	2.34	2.09	1.89	1.59	1.50
Type 3-3	80	218	31	473	44	1608	62	1.60	203	30	478	40	1486	55	1145	169	2351	198	5964	221	2.52	2.61	2.29	2.07	1.57	1.50

Table 9-5: ASR calculations for sample timber bridges.

Trucks	Weight [kips]	Live Load Effects Moment - M [kip-ft], and Shear - S [kips]							Dead Load Effects (Dead Load to Live Load Ratios of 0.5, 0.6, and 0.8 are used)						Capacity						Rating Factor					
									0.5	0.5	0.6	0.6	0.8	0.8	1.0	1.0	1.0	1.0	1.0	1.0						
		M	S	M	S	M	S	γLL	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S
		30	30	50	50	100	100	-	30	30	50	50	100	100	30	30	50	50	100	100	30	30	50	50	100	100
HS-20	72	406	60	797	67	1858	69	1.00	203	30	478	40	1486	55	609	90	1275	107	3344	124	1.00	1.00	1.00	1.00	1.00	1.00
Type 3	50	265	36	565	43	1315	50	1.23	203	30	478	40	1486	55	609	90	1275	107	3344	124	1.86	2.03	1.75	1.94	1.83	1.77
Type 3S2	72	266	35	516	48	1586	62	1.23	203	30	478	40	1486	55	609	90	1275	107	3344	124	1.85	2.10	1.92	1.73	1.52	1.43
Type 3-3	80	218	31	473	44	1608	62	1.23	203	30	478	40	1486	55	609	90	1275	107	3344	124	2.26	2.34	2.09	1.89	1.50	1.43

Table 9-6: Comparison of ASR and LFR Rating Factors with variable scale factors.

Load Effect	Span [ft]	Rating Factor Ratio ASR/LFR		
		Scale Factor 1.23	Scale Factor 1.15	Scale Factor 1.10
Moment	30	0.90	0.96	1.00
Shear	30	0.90	0.96	1.00
Moment	50	0.92	0.98	1.02
Shear	50	0.92	0.98	1.02
Moment	100	0.96	1.02	1.07
Shear	100	0.96	1.02	1.07

Chapter 10: Bridge Rating Examples

A probabilistic calibration established appropriate live load factors for AASHTO MBE LRTs to encompass Alaska's traffic conditions. Using the recommended live load factors, bridges can be rated for Alaska Legal and Routine Permit traffic. A key advantage of this approach is that it eliminates the need for additional rating trucks to represent all possible maximum truck configurations allowed by Alaska statutes. The probabilistic analysis showed that existing AASHTO MBE LRT rating vehicles can be used to accurately envelop expected live load effects. Instead of developing a new suite of rating trucks, the existing AASHTO trucks are used to encompass Alaska-specific traffic. The notional rating trucks do not need to correspond to real truck configurations, if their resulting force effects envelop those produced by Alaska traffic, ensuring the minimum safety requirement in terms of the reliability index specified by AASHTO is met.

Probabilistic analysis and calibration provide a simple method for updating load ratings by applying a scale factor to previously computed rating factors. For the bridges with existing rating factors, a scale factor approach can be used. The scale factor is defined as the ratio of the calibrated Alaska live load factor to the AASHTO MBE live load factor. The scale factor approach uses existing AASHTO MBE LRTs rating factors to determine ratings for Alaska Legal and Routine Permit traffic.

This chapter presents examples of the scale factor approach applied to various bridge span lengths, load cases, and rating methods, including LRFR with an ADTT of 1,000 and 5,000, LFR, and ASR.

10.1 Example 1 – LRFR for ADTT =1,000

This example demonstrates the process of updating existing operating rating factor calculations using the Load and Resistance Factor Rating (LRFR) method to account for Alaska Legal and Routine Permit traffic.

Given:

3-span continuous structure with a maximum span length of 200 feet

Critical force effect is the positive moment (M31)

ADTT = 1,000

Existing Rating Factors:

Vehicle	Level	Existing Rating Factor
HL-93	Inventory	0.50
HL-93	Operating	0.65
Type 3	Operating	1.60
Type 3S2	Operating	1.20
Type 3-3	Operating	1.15
Type 3-Lane	Operating	1.19
Type 3-Neg.	Operating	-
SU4	Operating	1.46
SU5	Operating	1.29
SU6	Operating	1.15
SU7	Operating	1.04

Solution:

Step 1: The study shows that AASHTO MBE LRTs can be used to represent Alaska Legal and Routine Permit traffic. Therefore, use the existing rating factors for the LRTs to account for Alaska Typical Trucks (AK) and LCVs (AK-LCV). To begin, add the Alaska-specific rating vehicles to the *Load Rating Summary Table*, then copy the existing LRT rating factors and paste them into the open cells of the *Existing Rating Factor* column for the Alaska-specific vehicles.

Step 2: Given that the existing rating factors are already available, adjust the existing rating factors using the scale factor. **Table 10-1** provides the relevant live load factors (LLF) and corresponding scale factors for this bridge. Identify the appropriate scale factors and enter them into the *Load Rating Summary Table*.

Table 10-1: LRFR Scale Factor at Operating Level for ADTT = 1,000

ADTT	Current AASHTO MBE LLF (Opr.)	Typical Vehicles (all spans)		LCVs (span ≥ 150 feet)	
		Rec. LLF (Opr.)	Corr. Scale Factor	Rec. LLF (Opr.)	Corr. Scale Factor
1,000	1.30	1.50	1.15	1.65	1.27

Step 3: Calculate the Adjusted Rating Factor by dividing the existing rating factor by the appropriate scale factor. **Table 10-2** shows the AASHTO MBE rating factors (unshaded cells), as well as the rating factors accounting for the Alaska legal and routine permit traffic using Typical Trucks (AK) and LCVs (AK-LCV) (shaded cells).

Table 10-2: Scale Factor Example LRFR for ADTT = 1,000

Load Rating Summary Table					
Vehicle	Level	Existing Rating Factor	Scale Factor	Adjusted Rating Factor	Final Rating Factor
HL-93	Inv.	0.50	-	-	0.50
HL-93	Opr.	0.65	-	-	0.65
Type 3	Opr.	1.60	-	-	1.60
Type 3S2	Opr.	1.20	-	-	1.20
Type 3-3	Opr.	1.15	-	-	1.15
Type 3-Lane	Opr.	1.19	-	-	1.19
Type 3-Neg.	Opr.	-	-	-	-
SU4	Opr.	1.46	-	-	1.46
SU5	Opr.	1.29	-	-	1.29
SU6	Opr.	1.15	-	-	1.15
SU7	Opr.	1.04	-	-	1.04
AK - Type 3	Opr.	1.60	1.15	1.39	1.39
AK - Type 3S2	Opr.	1.20	1.15	1.04	1.04
AK - Type 3-3	Opr.	1.15	1.15	1.00	1.00
AK - Type 3-Lane	Opr.	1.19	1.15	1.03	1.03
AK - Type 3-Neg.	Opr.	-	1.15	-	-
AK - LCV Type 3	Opr.	1.60	1.27	1.26	1.26
AK - LCV Type 3S2	Opr.	1.20	1.27	0.94	0.94
AK - LCV Type 3-3	Opr.	1.15	1.27	0.91	0.91
AK - LCV Type 3-Lane	Opr.	1.19	1.27	0.94	0.94
AK - LCV Type 3-Neg.	Opr.	-	1.27	-	-

10.2 Example 2 – LRFR for ADTT =5,000

This example demonstrates the process of updating existing operating rating factor calculations using the Load and Resistance Factor Rating (LRFR) method to account for Alaska Legal and Routine Permit traffic.

Given:

2-span continuous structure with a maximum span length of 30 feet

Critical force effect is negative moment (M22)

ADTT = 5,000

Existing Rating Factors:

Vehicle	Level	Existing Rating Factor
HL-93	Inventory	0.50
HL-93	Operating	0.65
Type 3	Operating	1.32
Type 3S2	Operating	0.88
Type 3-3	Operating	1.08
Type 3-Lane	Operating	-
Type 3-Neg.	Operating	1.20
SU4	Operating	1.30
SU5	Operating	1.10
SU6	Operating	0.99
SU7	Operating	0.81

Solution:

Step 1: The study shows that AASHTO MBE LRTs can be used to represent Alaska Legal and Routine Permit traffic. Therefore, use the existing rating factors for the LRTs to account for Alaska Typical Trucks (AK) and LCVs (AK-LCV). To begin, add the Alaska-specific rating vehicles to the *Load Rating Summary Table*, then copy the existing LRT rating factors and paste them into the open cells of the *Existing Rating Factor* column for the Alaska-specific vehicles.

Step 2: Given that the existing rating factors are already available, adjust the existing rating factors using the scale factor. **Table 10-3** provides the relevant live load factors (LLF) and corresponding scale factors for this bridge. Identify the appropriate scale factors and enter them into the *Load Rating Summary Table*.

Table 10-3: LRFR Scale Factor at Operating Level for ADTT = 5,000

ADTT	Current AASHTO MBE LLF (Opr.)	Typical Vehicles (all spans)		LCVs (span < 150 feet)	
		Rec. LLF (Opr.)	Corr. Scale Factor	Rec. LLF (Opr.)	Corr. Scale Factor
5000	1.45	1.60	1.10	1.60	1.10

Step 3: Calculate the Adjusted Rating Factor by dividing the existing rating factor by the appropriate scale factor. **Table 10-4** shows the AASHTO MBE rating factors (unshaded cells), as well as the rating factors accounting for the Alaska legal and routine permit traffic using Typical Trucks (AK) and LCVs (AK-LCV) (shaded cells). Note that AK and AK-LCV have the same scale factor as the bridge span length is less than 150 feet.

Table 10-4: Scale Factor Example LRFR for ADTT = 5,000

Load Rating Summary Table					
Vehicle	Level	Existing Rating Factor	Scale Factor	Adjusted Rating Factor	Final Rating Factor
HL-93	Inv.	0.50	-	-	0.50
HL-93	Opr.	0.65	-	-	0.65
Type 3	Opr.	1.32	-	-	1.32
Type 3S2	Opr.	0.88	-	-	0.88
Type 3-3	Opr.	1.08	-	-	1.08
Type 3-Lane	Opr.	-	-	-	-
Type 3-Neg.	Opr.	1.20	-	-	1.20
SU4	Opr.	1.30	-	-	1.30
SU5	Opr.	1.10	-	-	1.10
SU6	Opr.	0.99	-	-	0.99
SU7	Opr.	0.81	-	-	0.81
AK - Type 3	Opr.	1.32	1.10	1.20	1.20
AK - Type 3S2	Opr.	0.88	1.10	0.80	0.80
AK - Type 3-3	Opr.	1.08	1.10	0.98	0.98
AK - Type 3-Lane	Opr.	-	1.10	-	-
AK - Type 3-Neg.	Opr.	1.20	1.10	1.09	1.09
AK - LCV Type 3	Opr.	1.32	1.10	1.20	1.20
AK - LCV Type 3S2	Opr.	0.88	1.10	0.80	0.80
AK - LCV Type 3-3	Opr.	1.08	1.10	0.98	0.98
AK - LCV Type 3-Lane	Opr.	-	1.10	-	-
AK - LCV Type 3-Neg.	Opr.	1.20	1.10	1.09	1.09

10.3 Example 3 – LFR

This example demonstrates the process of updating existing operating rating factor calculations using the Load Factor Rating (LFR) method to account for Alaska Legal and Routine Permit traffic.

Given:

Simple span structure with a span length of 300 feet

Critical force effect is positive moment (M11)

Existing Rating Factors:

Vehicle	Level	Existing Rating Factor
HS-20	Inventory	0.50
HS-20	Operating	0.83
Type 3	Operating	1.98
Type 3S2	Operating	1.45
Type 3-3	Operating	1.34
Type 3 Truck Train	Operating	1.14
Type 3S2 Truck Train	Operating	0.87
Type 3-3 Truck Train	Operating	0.83
SU4	Operating	1.82
SU5	Operating	1.60
SU6	Operating	1.43
SU7	Operating	1.29

Solution:

Step 1: The study shows that AASHTO MBE LRTs can be used to represent Alaska Legal and Routine Permit traffic. Therefore, use the existing rating factors for the LRTs to account for Alaska Typical Trucks (AK) and LCVs (AK-LCV). To begin, add the Alaska-specific rating vehicles to the *Load Rating Summary Table*, then copy the existing LRT rating factors and paste them into the open cells of the *Existing Rating Factor* column for the Alaska-specific vehicles.

Step 2: Given that the existing rating factors are already available, adjust the existing rating factors using the scale factor. **Table 10-5** provides the relevant live load factors (LLF) and corresponding scale factors for this bridge. Identify the appropriate scale factors and enter them into the *Load Rating Summary Table*.

Table 10-5: LFR Scale Factors at Operating Level

Current AASHTO MBE LLF (Opr.)	Typical Vehicles (all spans)		LCVs (span $\geq$ 150 feet)	
	Rec. LLF (Opr.)	Corr. Scale Factor	Rec. LLF (Opr.)	Corr. Scale Factor
1.30	1.60	1.23	1.75	1.35

Step 3: Calculate the Adjusted Rating Factor by dividing the existing rating factor by the appropriate scale factor. **Table 10-6** shows the AASHTO MBE rating factors (unshaded cells), as well as the rating factors accounting for the Alaska legal and routine permit traffic using Typical Trucks (AK) and LCVs (AK-LCV) (shaded cells).

Table 10-6: Scale Factor Example for LFR

Load Rating Summary Table					
Vehicle	Level	Existing Rating Factor	Scale Factor	Adjusted Rating Factor	Final Rating Factor
HS-20	Inv.	0.50	-	-	0.50
HS-20	Opr.	0.83	-	-	0.83
Type 3	Opr.	1.98	-	-	1.98
Type 3S2	Opr.	1.45	-	-	1.45
Type 3-3	Opr.	1.34	-	-	1.34
Type 3 Truck Train	Opr.	1.14	-	-	1.14
Type 3S2 Truck Train	Opr.	0.87	-	-	0.87
Type 3-3 Truck Train	Opr.	0.83	-	-	0.83
SU4	Opr.	1.82	-	-	1.82
SU5	Opr.	1.60	-	-	1.60
SU6	Opr.	1.43	-	-	1.43
SU7	Opr.	1.29	-	-	1.29
AK - Type 3	Opr.	1.98	1.23	1.61	1.61
AK - Type 3S2	Opr.	1.45	1.23	1.18	1.18
AK - Type 3-3	Opr.	1.34	1.23	1.09	1.09
AK - Type 3 Truck Train	Opr.	1.14	1.23	0.93	0.93
AK - Type 3S2 Truck Train	Opr.	0.87	1.23	0.71	0.71
AK - Type 3-3 Truck Train	Opr.	0.83	1.23	0.67	0.67
AK - LCV Type 3	Opr.	1.98	1.35	1.47	1.47
AK - LCV Type 3S2	Opr.	1.45	1.35	1.07	1.07
AK - LCV Type 3-3	Opr.	1.34	1.35	0.99	0.99
AK - LCV Type 3 Truck Train	Opr.	1.14	1.35	0.84	0.84
AK - LCV Type 3S2 Truck Train	Opr.	0.87	1.35	0.64	0.64
AK - LCV Type 3-3 Truck Train	Opr.	0.83	1.35	0.61	0.61

10.4 Example 4 – ASR

This example demonstrates the process of updating existing operating rating factor calculations using the Allowable Stress Rating (ASR) method to account for Alaska Legal and Routine Permit traffic.

Given:

Simple span structure with a maximum span length of 100 feet

Critical force effect is end shear (S1)

Existing Rating Factors:

Vehicle	Level	Existing Rating Factor
HS-20	Inventory	0.50
HS-20	Operating	0.83
Type 3	Operating	1.13
Type 3S2	Operating	0.91
Type 3-3	Operating	0.91
Type 3 Truck Train	Operating	-
Type 3S2 Truck Train	Operating	-
Type 3-3 Truck Train	Operating	-
SU4	Operating	1.05
SU5	Operating	0.94
SU6	Operating	0.86
SU7	Operating	0.78

Solution:

Step 1: The study shows that AASHTO MBE LRTs can be used to represent Alaska Legal and Routine Permit traffic. Therefore, use the existing rating factors for the LRTs to account for Alaska Typical Trucks (AK) and LCVs (AK-LCV). To begin, add the Alaska-specific rating vehicles to the *Load Rating Summary Table*, then copy the existing LRT rating factors and paste them into the open cells of the *Existing Rating Factor* column for the Alaska-specific vehicles.

Step 2: Given that the existing rating factors are already available, adjust the existing rating factors using the scale factor. **Table 10-7** provides the relevant scale factors for this bridge. Enter the scale factors into the *Load Rating Summary Table*.

Table 10-7: Scale Factor for ASR at Operating Level

Current AASHTO MBE LLF (Opr.)	Typical Vehicles and LCVs (all spans)	
	Recommended LLF (Opr.)	Corresponding Scale Factor
N/A	N/A	1.23

Step 3: Calculate the Adjusted Rating Factor by dividing the existing rating factor by the appropriate scale factor. **Table 10-8** shows the AASHTO MBE rating factors (unshaded cells), as well as the rating factors accounting for the Alaska legal and routine permit traffic using Typical Trucks (AK) and LCVs (AK-LCV) (shaded cells). Note that AK and AK-LCV have the same scale factor as the bridge span length is less than 150 feet.

Table 10-8: Scale Factor Example for ASR

Load Rating Summary Table					
Vehicle	Level	Existing Rating Factor	Scale Factor	Adjusted Rating Factor	Final Rating Factor
HS-20	Inv.	0.50	-	-	0.50
HS-20	Opr.	0.83	-	-	0.83
Type 3	Opr.	1.13	-	-	1.13
Type 3S2	Opr.	0.91	-	-	0.91
Type 3-3	Opr.	0.91	-	-	0.91
Type 3 Truck Train	Opr.	-	-	-	-
Type 3S2 Truck Train	Opr.	-	-	-	-
Type 3-3 Truck Train	Opr.	-	-	-	-
SU4	Opr.	1.05	-	-	1.05
SU5	Opr.	0.94	-	-	0.94
SU6	Opr.	0.86	-	-	0.86
SU7	Opr.	0.78	-	-	0.78
AK - Type 3	Opr.	1.13	1.23	0.92	0.92
AK - Type 3S2	Opr.	0.91	1.23	0.74	0.74
AK - Type 3-3	Opr.	0.91	1.23	0.74	0.74
AK - Type 3 Truck Train	Opr.	-	1.23	-	-
AK - Type 3S2 Truck Train	Opr.	-	1.23	-	-
AK - Type 3-3 Truck Train	Opr.	-	1.23	-	-
AK - LCV Type 3	Opr.	1.13	1.23	0.92	0.92
AK - LCV Type 3S2	Opr.	0.91	1.23	0.74	0.74
AK - LCV Type 3-3	Opr.	0.91	1.23	0.74	0.74
AK - LCV Type 3 Truck Train	Opr.	-	1.23	-	-
AK - LCV Type 3S2 Truck Train	Opr.	-	1.23	-	-
AK - LCV Type 3-3 Truck Train	Opr.	-	1.23	-	-

Summary of the Study

The load rating study led to several key conclusions and associated recommendations for bridge rating of Alaska legal and routine permit traffic, which are summarized below:

- The AASHTO MBE legal truck model does not encompass Alaska legal and routine permit traffic. Therefore, a new rating method is required to encompass Alaska's legal and routine permit loads.
- The AASHTO MBE Legal Rating Trucks (LRTs), including the Type 3, 3S2, and 3-3 trucks, were found to be suitable notional truck models for Alaska legal traffic. These trucks produced uniform bias factors across various span lengths and a consistent reliability index using a single live load factor. To achieve the target reliability index, the current AASHTO MBE LRT operating live load factors should be increased to 1.50 for an ADTT of 1,000 and 1.60 for an ADTT of 5,000.
- AASHTO Specialized Hauling Vehicles (SHV), such as SU4–SU7 trucks, were found not suitable to represent Alaska legal traffic. These trucks produced inconsistent bias factors for short-span and long-span bridges and thus are not appropriate to be modeled by a single live load factor to produce a uniform target reliability index. Therefore, no change to standard load rating practices is needed for SHVs.
- Ore trucks, which are double tractor-trailer 16-axle vehicles measuring 95 feet and legally carrying 162.5 kips, were not observed in the available WIM data. A separate simulation was conducted for an expected ore truck traffic (120 trucks daily). Results showed that short-span bridges remain unaffected by ore trucks, while long-span bridges still meet the target reliability index when using a live load factor of 1.60. The findings confirm that the AASHTO MBE LRT model, with the proposed live load factor increase, adequately encompasses ore truck traffic.
- Alaska Long Combination Vehicles (LCVs), defined as vehicles with wheelbases exceeding 75 feet, were analyzed separately. The bias factor for LCV shows lower values for short spans and higher values for long-span bridges. To meet the target reliability index, the live load factor should be increased to 1.65 for ADTT 1,000 and 1.75 for ADTT 5,000 for bridges with a maximum span length greater than 150 feet to encompass the effects of Alaska LCVs.
- A deterministic analysis was completed using 64 representative vehicle configurations with maximized weights for legal and routine permit traffic as defined by Alaska statutes. Conservatively, all Alaska truck candidate force effects were multiplied by an LLF of 1.30. While this approach produced ratios that in some cases suggest overstress, these results are provided solely for reference. They should not be interpreted as evidence that the proposed calibration recommendations are invalid. Rather, the deterministic analysis simply reflects force-effect ratios obtained by applying a 30% increase to maximized truck loads, without accounting for key factors that govern structural reliability, including the actual traffic composition, frequency of occurrence, and variability, and the probabilistic measures of safety - the reliability index. Therefore, the apparent overstress in deterministic ratios does

not undermine the appropriateness or validity of the reliability-based calibration framework.

- Recommended LRFR live load factors for typical traffic are 1.50 for ADTT = 1,000 and 1.60 for ADTT = 5,000. For LCVs, factors of 1.65 and 1.75 are recommended. Under LFR, a single factor of 1.60 is proposed for typical traffic and 1.75 for LCVs. An ASR scale factor of 1.23 is recommended. For LRFR, the larger LLFs can be used for simplicity.
- A scale factor based on the ratio of the recommended live load factor to the current AASHTO MBE load factors is proposed to simplify bridge re-rating and reduce implementation costs.

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Appendices

Appendix A: Excerpts from CFR Title 23, Part 658

Appendix A

§ 658.3 Policy statement

The Federal Highway Administration's (FHWA) policy is to provide a safe and efficient National Network of highways that can safely and efficiently accommodate the large vehicles authorized by the STAA. This network includes the Interstate System plus other qualifying Federal-aid Primary System Highways.

§ 658.13 Length

(a) The length provisions of the STAA apply only to the following types of vehicle combinations:

- (1) Truck tractor-semitrailer
- (2) Truck tractor-semitrailer-trailer.

The length provisions apply only when these combinations are in use on the National Network or in transit between these highways and terminals or service locations pursuant to § 658.19.

(b) The length provisions referred to in paragraph (a) of this section include the following:

- (1) No State shall impose a length limitation of less than 48 feet on a semitrailer operating in a truck tractor-semitrailer combination.
- (2) No State shall impose a length limitation of less than 28 feet on any semitrailer or trailer operating in a truck tractor-semitrailer-trailer combination.
- (3) No State shall impose an overall length limitation on commercial vehicles operating in truck tractor-semitrailer or truck tractor-semitrailer-trailer combinations.
- (4) No State shall prohibit commercial motor vehicles operating in truck tractor-semitrailer-trailer combinations.
- (5) No State shall prohibit the operation of semitrailers or trailers which are 28½ feet long when operating in a truck tractor-semitrailer-trailer combination if such a trailer or semitrailer was in actual and lawful operation on December 1, 1982, and such combination had an overall length not exceeding 65 feet.

§ 658.17 Weight

(a) Click to open paragraph tools The provisions of the section are applicable to the National System of Interstate and Defense Highways and reasonable access thereto.

(b) The maximum gross vehicle weight shall be 80,000 pounds except where lower gross vehicle weight is dictated by the bridge formula.

(c) The maximum gross weight upon any one axle, including any one axle of a group of axles, or a vehicle is 20,000 pounds.

(d) The maximum gross weight on tandem axles is 34,000 pounds.

(e) No vehicle or combination of vehicles shall be moved or operated on any Interstate highway when the gross weight on two or more consecutive axles exceeds the limitations prescribed by the following formula, referred to as the Bridge Gross Weight Formula:

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

Where W =overall gross weight on any group of two (2) or more consecutive axles to the nearest five hundred pounds (500 lbs.), L =distance in feet between the extreme of any group of two (2) or more consecutive axles, and N =number of axles in group under consideration, except that two consecutive sets of tandem axles may carry a gross load of 34,000 pounds each if the overall distance between the first and last axle is 36 feet or more. In no case shall the total gross weight of a vehicle exceed 80,000 pounds.

(f) Except as provided herein, States may not enforce on the Interstate System vehicle weight limits of less than 20,000 pounds on a single axle, 34,000 pounds on a tandem axle, or the weights derived from the Bridge Formula, up to a maximum of 80,000 pounds, including all enforcement tolerances. States may not limit tire loads to less than 500 pounds per inch of tire or tread width, except that such limits may not be applied to tires on the steering axle. States may not limit steering axle weights to less than 20,000 pounds or the axle rating established by the manufacturer, whichever is lower.

(...)

(n) Any vehicle subject to this subpart that utilizes an auxiliary power or idle reduction technology unit in order to promote reduction of fuel use and emissions because of engine idling, may be allowed up to an additional 400 lbs. total in gross, axle, tandem, or bridge formula weight limits.

(1) To be eligible for this exception, the operator of the vehicle must be able to prove:

(i) By written certification, the weight of the APU; and

(ii) By demonstration or certification, that the idle reduction technology is fully functional at all times.

(2) Certification of the weight of the APU must be available to law enforcement officers if the vehicle is found in violation of applicable weight laws. The additional weight allowed cannot exceed 400 lbs. or the weight certified, whichever is less.

§ 658 Appendix B to Part 658—Grandfathered Semitrailer Lengths

Grandfathered Semitrailer Length for Alaska is 48 ft.

§ 658 Appendix C Trucks Over 80,000 Pounds on the Interstate System and Trucks Over STAA Lengths on the National Network

Grandfathered Semitrailer Length for Alaska is 48 ft.

STATE: ALASKA

COMBINATION: Truck tractor and 2 trailing units

LENGTH OF THE CARGO-CARRYING UNITS: 95 feet

OPERATIONAL CONDITIONS:

WEIGHT: The combination must be in compliance with State laws and regulations. There are no highways in the State subject to Interstate System weight limits. Therefore, the ISTEA freeze as it applies to maximum weight is not applicable.

DRIVER: The driver must have a commercial driver's license with the appropriate endorsement.

VEHICLE: Combinations with an overall length greater than 75 feet, measured bumper to bumper, must display an "OVERSIZE##" warning sign on the front and rear. In combinations where one cargo-carrying unit is more than 5,000 pounds heavier than the other, the heavier unit shall be placed immediately behind the power unit. Weather restrictions are imposed when hazardous conditions exist, as determined by the Alaska Department of Transportation and Public Facilities (DOT&PF) and the Alaska Department of Public Safety, Division of State Troopers. Time of day travel is not restricted.

PERMIT: None required.

ACCESS: Alaska allows reasonable access not to exceed 5 miles to reach or return from terminals and facilities for food, fuel, or rest. The most direct route must be used. The Commissioner of the Alaska DOT&PF may allow access to specific routes if it can be shown that travel frequency, necessity, and route accommodation are required.

Routes:

	From	To
AK-1	Anchorage (Potter Weigh Station)	Palmer (Palmer-Wasilla Highway Junction).
AK-2	Fairbanks (Gaffney Road Junction)	Delta Junction (MP 1412 Alaska Highway).
AK-3	Jct. AK-1	Fairbanks (Gaffney Road Junction).

COMBINATION: Truck tractor and 3 trailing units
LENGTH OF THE CARGO-CARRYING UNITS: 110 feet

OPERATIONAL CONDITIONS:

WEIGHT and ACCESS: Same as the AK-TT2 combination.

DRIVER: The driver must have a commercial driver's license with the appropriate endorsement. Drivers of this combination must have 10 years of experience in Alaska and certified training in operation of these combinations.

VEHICLE: Individual trailer length in a three trailing unit combination shall not exceed 28.5 feet.

Engine horsepower rating shall not be less than 400 horsepower.

These combinations are allowed to operate only between May 1 and September 30 of each year. Weather restrictions are imposed when hazardous conditions exist, as determined by the Alaska DOT&PF and the Department of Public Safety, Division of State Troopers. No movement is permitted if visibility is less than 1,000 feet.

PERMIT: Permits are required with specified durations of not less than 3 months or more than 18 months. There is a fee.

Routes:

	From	To
AK-1	Anchorage (Potter Weigh Station)	Jct. AK-3.
AK-3	Jct. AK-1	Fairbanks (Gaffney Road Junction)

COMBINATION: Truck-trailer
LENGTH OF THE CARGO-CARRYING UNITS: 83 feet

OPERATIONAL CONDITIONS:

WEIGHT, DRIVER, PERMIT, and ACCESS: Same as the AK-TT2 combination.

VEHICLE: Same as the AK-TT2 combination, except that overall combination length may not exceed 90 feet.

ROUTES: Same as the AK-TT2 combination.

LEGAL CITATIONS: Same as the AK-TT2 combination

Appendix B: Excerpts from Alaska Administrative Code Title 17

Appendix B

AAC Title 17 Chapter 25.012 - Legal vehicle size

(a) The width of a vehicle, including load, may not exceed 102 inches. Equipment may extend no more than three inches beyond the 102-inch width limitation on each side of the vehicle if the equipment is attached to the vehicle. However, the following items are not subject to the maximum width requirements of this subsection:

- (1) rear view mirrors;
- (2) turn signal lamps;
- (3) handholds for entry into or egress from the cab;
- (4) splash and spray suppressant devices;
- (5) load-induced tire bulge;
- (6) recreational vehicle awnings in the retracted position;
- (7) manufacturer-installed appurtenances, including alternating-current (AC) power outlets and exhaust fans.

(b) A vehicle, including load, may not exceed a height of 15 feet except that a vehicle operating between the Fox Weigh Station and Prudhoe Bay on the Dalton and Elliott Highways may have a height, including load, of 17 feet.

(c) The following maximum lengths may not be exceeded on National Highway System (NHS) routes listed in the department's publication entitled *State of Alaska, National Highway System Maps*, dated April 2006, and adopted by reference:

- (1) the length of a power vehicle may not exceed 45 feet;
- (2) repealed 12/31/2006;
- (3) the cargo-carrying length of a semitrailer or trailer may not exceed 53 feet;
- (4) the overall length of a combination of vehicles, consisting of a truck and one cargo-carrying vehicle or a truck tractor and two cargo-carrying vehicles, may not exceed 75 feet; however, a combination of a truck tractor and one cargo-carrying vehicle is not subject to an overall length limit;
- (5) long combination vehicles (LCVs) may not exceed the maximum lengths set out in 17 AAC 25.014;
- (6) a load or equipment may not overhang or extend more than
 - (A) three feet beyond the front bumper of the vehicle; or
 - (B) four feet beyond the rear of a vehicle.

(d) The following maximum lengths may not be exceeded on the state highway system, other than routes described in (c) of this section:

- (1) the length of a power vehicle may not exceed 45 feet;
- (2) the cargo-carrying length of a semitrailer or trailer may not exceed 53 feet;
- (3) the overall length of a combination of vehicles, consisting of a truck and one cargo-carrying vehicle or a truck tractor and one or two cargo-carrying vehicles, may not exceed 75 feet;
- (4) a load or equipment may not overhang or extend more than
 - (A) three feet beyond the front bumper of the vehicle; or
 - (B) four feet beyond the rear of the vehicle.

(e) On all routes

- (1) a semitrailer used in combination may not exceed 53 feet in length;
- (2) a load or equipment may not overhang more than four feet beyond the rear of a semitrailer used in combination; and
- (3) combinations may not have more than two cargo-carrying vehicles in the combination.
- (f) Vehicles within the limitations set out in (c) of this section may move to and from routes specified in (c) of this section to access or return from terminals or facilities for fuel, servicing, delivering or receiving cargo, or food and rest for the vehicle operator. A vehicle must use the most direct interconnecting truck route wherever possible when moving to or from the specified routes. Vehicle movement off the state highway system is subject to local ordinance. A vehicle moving to or from specified routes may not travel further than a five-mile distance from these routes, except if using roads identified in 17 AAC 25.014(f) (1) - (7).

(g) Equipment is not included in the vehicle size limitations contained in (a), (c), (d), and (e) of this section, except as specifically provided.

Eff. 8/13/95, Register 135; am 10/7/2001, Register 160; am 11/16/2004, Register 172; am 12/31/2006, Register 180; am 4/9/2009, Register 190; am 12/30/2010, Register 196; am 11/26/2015, Register 216, January 2016; am 12/6/2018, Register 228, January 2019.

AAC Title 17 Chapter 25.013 - Legal vehicle weight

(a) Except as provided in 17 AAC 25.335, the weight of a vehicle or combination of vehicles, including load and equipment, operated or moved on the state highway system may not exceed a limit set out in this section. If more than one weight limit applies, the most restrictive limitation will be used to determine the maximum allowable weight, as follows:

- (1) the weight on a tire may not exceed 600 pounds per linear inch of tire width based upon the tire manufacturer's rating of nominal tire width;
- (2) repealed 4/12/2013;
- (3) repealed 4/12/2013;
- (4) except as provided in (5) of this subsection, for a vehicle or combination of vehicles, including load and equipment, the weight on axles or axle groups may not exceed, and the distance between axles may not be less than, the following:

	Weight (pounds)	Distance
Single Axle	20,000	8 feet and 1 inch minimum spacing*
2-Axle Group	38,000	3 feet and 6 inches minimum spacing
3-Axle Group	42,000	3 feet and 6 inches minimum spacing
4-Axle Group	50,000	3 feet and 6 inches minimum spacing

* Any axle spaced less than 8 feet and 1 inch from any other axle, measured between the centers of the nearest axles, is considered as part of an axle group. In multi-axle groups, all axles must carry at least

6,000 pounds if the axle group weight is more than 50 percent of the legal group weight. Lift axles or variable suspension axles are allowed in the drive axle group of the power vehicle but may not be used to determine the legal allowable vehicle gross weight prescribed by the Bridge Gross Weight Formulas in (a)(6) of this section.

(5) if the combination is a truck-tractor and single semitrailer combination where the length of the semitrailer is 48 feet or more, the weight on a three-axle group on the semitrailer may not exceed, and the distance between the axles may not be less than the following:

Weight (pounds) Distance 42,000 3 feet and 6 inches minimum spacing 43,500 5 feet minimum spacing 45,000 6 feet minimum spacing

(6) the maximum gross vehicle weight for a vehicle or vehicle combination may not exceed the amount prescribed by the following formulas, referred to as the Bridge Gross Weight Formulas:

(A) maximum gross vehicle weight for a vehicle with lift axles in the drive axle group may not be greater than the weight determined under the following formula:

$$W = 500 [LN / N-1 + 12N + 36]$$

where:

W = the maximum gross vehicle weight to the nearest 500 pounds;

L = the distance in whole feet, measured between the centers of the extreme axles for the vehicle or the vehicle combination; a measurement including a fractional portion of a foot is stated as the next higher whole number; and

N = the number of axles on the vehicle or vehicle combination and does not include lift axles in the drive axle group of a power vehicle;

(B) the maximum gross vehicle weight for a vehicle with no lift axles in the drive axle groups may not be greater than the weight determined under the following formula:

$$W = 500 [LN / N-1 + 12N + 36] + 3,000$$

where:

W = the maximum gross vehicle weight to the nearest 500 pounds;

L = the distance in whole feet, measured between the centers of the extreme axles for the vehicle or the vehicle combination; a measurement including a fractional portion of a foot is stated as the next higher whole number; and

N = the number of axles on the vehicle or vehicle combination.

(b) In a combination of a power vehicle and two or more cargo-carrying vehicles consisting of trailers or semitrailers, the heavier cargo-carrying vehicle must be placed immediately behind the power vehicle when one cargo-carrying vehicle is more than 5,000 pounds heavier than any other cargo-carrying vehicle in the combination. The weight of the power vehicle and the first cargo-carrying vehicle in a combination with two or more cargo-carrying vehicles may not exceed the weight allowable in this section for a power vehicle and single cargo-carrying vehicle with the same axle configuration and of equal length, calculated without regard to the weight of the following cargo-carrying vehicles in the combination.

(c) The weight carried by individual axle groups before or after pintle hooks or other connecting devices in vehicle combinations may not exceed the standards for axle group weights set out in this section.

(d) Between October 1 and March 31, shifting of legal axle weights set out in (a)(4) and (5) of this section is allowed for one, two, and three drive axle groupings on power vehicles traveling on the Steese, Elliott, Dalton, and Richardson Highways between North Pole and Prudhoe Bay, or between North Pole and MP 30 of the Steese Highway. The shifted weight on these drive axle groupings may not exceed 2,000 pounds per axle. The legal allowable gross weight on a vehicle or combination of vehicles may not exceed the maximum weight as determined by methods set out in this section. An overweight permit is not required for shifting additional weight to the drive axle group during the period defined. Traction weight shifting is not allowed for a power vehicle traveling under an overweight permit. Vehicle combinations operating with traction-weight shifting on the power vehicle will be allowed reasonable right of access to and from the Steese, Elliott, and Dalton Highways, when traveling between Fairbanks and Prudhoe Bay, to reach or return from terminals and facilities for food, fuel, and rest, if the vehicle uses the most direct truck route whenever possible and moves no farther than five miles from the most direct route between North Pole and Fox. All movement within organized municipalities and boroughs is subject to local ordinances in addition to the requirements of this chapter.

(e) Except when an emergency requires immediate action, if the department determines that a highway may be damaged by a vehicle's weight, weight restrictions may be imposed after appropriate notice has been given to the public. When weight restrictions are imposed, they will be stated as a percentage of the legal allowable axle weights and applied to the maximum axle loading specified in this section. The weight on steering axles may not be restricted below 100 percent of the legal allowable axle weight. Unless approved by the department, a permit issued under 17 AAC 25.320 allowing overweight vehicles does not satisfy the requirements of this chapter in order to travel on weight-restricted highways during the period when weight restrictions are imposed.

(f) For purposes of this section, "pounds per inch of tire width" is determined by dividing the sum of the tire width in inches for tires mounted on an axle group into the weight carried on that axle group in pounds.

(g) A vehicle subject to the provisions of this section that uses an auxiliary power unit or an idle reduction technology unit in order to promote reduction of fuel use and emissions because of engine idling, will be allowed up to an additional 550 pounds total in power unit axle weights, gross vehicle weights, or bridge formula weight limits. Certification of the weight of the auxiliary power unit must be available to law enforcement officers if the vehicle is found in violation of applicable weight laws. The additional weight allowed may not exceed 550 pounds or the weight certified, whichever is less. To be eligible for this exception, the operator of the vehicle must be able to prove by:

- (1) written certification, the weight of the auxiliary power unit or idle reduction technology unit; and
- (2) demonstration or certification, that the auxiliary power unit or idle reduction technology unit is fully functional at all times.

Eff. 8/13/95, Register 135; am 10/7/2001, Register 160; am 12/31/2006, Register 180; am 4/9/2009, Register 190; am 12/30/2010, Register 196; am 4/12/2013, Register 206; am 11/26/2015, Register 216, January 2016; am 12/6/2018, Register 228, January 2019

AAC Title 17 Chapter 25.014 - Allowable Long Combination Vehicle Length on Certain Routes

(a) A long combination vehicle (LCV) with a cargo-carrying length that does not exceed 95 feet, measured from the front of the first cargo-carrying vehicle to the rear of the last cargo-carrying vehicle or load, including the connecting device, may operate upon one or more of the following routes, if individual trailers or semi-trailers in an LCV do not exceed 48 feet in cargo-carrying length:

- (1) the Sterling, Seward and Glenn Highways, Alaska Route 1 (AK-1), from Homer to the junction with the Palmer-Wasilla Highway in Palmer.
- (2) the Tok Cutoff, AK-1, from the junction with the Richardson Highway, Alaska Route 4 (AK-4), in Gakona Junction to the junction with the Alaska Highway, Alaska Route 2 (AK-2), in Tok.
- (3) the Alaska Highway, AK-2, from the Canadian border to the junction with the Richardson Highway, AK-4, in Delta Junction.
- (4) the Seward, Glenn, and Parks Highways, AK-1 and Alaska Route 3 (AK-3), from the Potter Weigh Station in Anchorage to the junction with the Parks Highway, AK-3, to the junction with the Richardson Highway, AK-2, in Fairbanks via the Mitchell Expressway; for purposes of this paragraph, the lead trailer in a truck tractor, two-trailer LCV may have a cargo carrying length of 53 feet, if the total cargo carrying length, including the connecting device, does not exceed 95 feet.
- (5) the Richardson Highway, AK-4 and AK-2, from the Alaska Marine Highway System ferry terminal in Valdez to the junction with the Mitchell Expressway, AK-3, in Fairbanks.
- (6) the Seward Highway, Alaska Route 9 (AK-9), from the junction with the Sterling Highway, AK-1, to Seward.
- (7) the Kenai Spur Highway, from the junction with the Sterling Highway, AK-1, to Nikishka Dock.

(b) A long combination vehicle, consisting of a truck and one cargo-carrying vehicle whose overall length does not exceed 90 feet may operate upon the:

- (1) Seward and Glenn Highways, AK-1, from the Potter Weigh Station in Anchorage to the junction with the Palmer-Wasilla Highway in Palmer.
- (2) Parks Highway, AK-3, from the junction with the Glenn Highway, AK-1, to the junction with the Richardson Highway, AK-2, in Fairbanks via the Mitchell Expressway; and
- 3) Richardson and Alaska Highways, AK-2, from the junction with Gaffney Road in Fairbanks to Milepost 1412 of the Alaska Highway, near Delta Junction.

(c) A long combination vehicle, consisting of a truck and one cargo-carrying vehicle, a truck tractor and one cargo-carrying vehicle, or a truck tractor and two cargo-carrying vehicles, whose overall length does not exceed 95 feet may operate upon the:

- (1) Haines Highway, Alaska Route 7 (AK-7), from the Alaska Marine Highway System ferry terminal in Haines to the Canadian border
- (2) Glenn Highway, AK-1, from the junction with the Palmer-Wasilla Highway in Palmer to the junction with the Richardson Highway, AK-4, in Glennallen
- (3) North Slope Haul Road between Fairbanks and Prudhoe Bay, consisting of the:

(A) Richardson Highway, Steese Expressway, and Elliot Highway, AK-2, from the junction with the Mitchell Expressway, AK-3, in Fairbanks to the junction with the Dalton Highway, Alaska Route

11 (AK-11); and

(B) Dalton Highway, AK-11, from the junction with the Elliot Highway, AK-2, to Prudhoe Bay; and

4) Klondike Highway, Alaska Route 98 (AK-98), from the Alaska Marine Highway System ferry terminal in Skagway to the Canadian border.

(d) A long combination vehicle configured in a truck tractor and a triple cargo-carrying vehicle combination may operate only on the Glenn and Parks Highways, AK-1 and AK-3, between Anchorage and Fairbanks during the period from May 1 through September 30 of each year by permit issued under this chapter, with notice provided by the applicant to municipalities along the route, if:

- (1) each combination, including load, does not exceed 120 feet in overall length;
- (2) each individual vehicle in the combination does not exceed 28.5 feet in length;
- (3) the power vehicle engine power rating is not less than 400 horsepower; and
- (4) except on the steering axle, each axle has four mounted tires or wide-base single tires.

(...)

AAC Title 17 Chapter 25.320 - Permits for oversize or overweight vehicles

(a) The department will issue a permit authorizing the movement of a vehicle or load of a size or weight exceeding the limitations specified in this chapter if the department determines that

- (1) the overweight vehicle or load is a non-divisible vehicle or load; or
- (2) each of the following requirements is met:
 - (A) the state's best interests are served by the permit;
 - (B) the usefulness of the highways traveled is not diminished;
 - (C) the safety of other users is not compromised;
 - (D) the traveling public will not be unreasonably inconvenienced.

(b) As it considers necessary to assure that the requirements listed in (a) of this section are met, the department will, as conditions for a permit issued under (a)(1) or (2) of this section, establish time limitations for movement, designate routes, limit the number of trips, or otherwise restrict the movement of oversize or overweight vehicles and loads. The movement of permitted oversize or overweight vehicles or loads must comply with the conditions of the permit and requirements for towing vehicles, pilot cars, warning signs and lights, hours of darkness, and other safety considerations specified in the department's Administrative Permit Manual: Oversize and Overweight Permits, revised as of February 2019, and adopted by reference.

(c) Subject to its determination that the requirements listed in (a)(2)(A) - (D) of this section are met, the department will, in a permit issued under (a)(1) or (a)(2) of this section, authorize movement of an

oversize or overweight vehicle or load over an extended period of up to one year. However, in a permit issued under (a)(1) or (a)(2) of this section, the department will not authorize movement over an extended period for any of the following vehicles:

- (1) vehicles or loads over 10 feet 6 inches wide under 17 AAC 25.012(a);
- (2) vehicles or loads over 15 feet high, other than vehicles or loads exempt under 17 AAC 25.012(b);
- (3) vehicles or loads over 17 feet high operating between the Fox Weigh Station and Prudhoe Bay on the Dalton and Elliott Highways;
- (4) vehicles or loads that exceed legal length under this chapter;
- (5) vehicles or loads with a rear overhang that exceeds 10 feet;
- (6) vehicles or loads that exceed 125 percent of legal weight under this chapter.

(d) Issuance of a permit does not relieve the vehicle operating under the permit from the requirement of 17 AAC 25.310.

(e) If a vehicle operating under a permit breaks down to a degree that roadside repairs are impractical or impossible, a similar vehicle may be substituted for the vehicle described in the permit if the substitute vehicle is validly registered under AS 28.10 and if the substitution does not materially alter the conditions listed on the original application for the permit. The driver, owner, or lessee shall report a substitution at the nearest weigh station along the route of travel or to the division's commercial vehicle customer service center.

(f) The department may deny a permit to a person who has incurred three or more violations under AS 45.75.380(a)(10) or (11) during the 90-day period immediately preceding the date the person submits the permit application.

Eff. 10/7/2001, Register 160; am 11/16/2004, Register 172; am 12/31/2006, Register 180; am 12/30/2010, Register 196; am 4/12/2013, Register 206; am 11/26/2015, Register 216, January 2016; am 12/6/2018, Register 228, January 2019; am 4/4/2020, Register 234, April 2020

AAC Title 17 Chapter 25.335 - Weighing allowance

(a) The department will weigh vehicles in their as-found condition and will grant weight allowances, as described in this section, to the weight limits set out in 17 AAC 25.013.

(b) The department will observe the following procedures if enforcing the gross weight requirements in 17 AAC 25.013

- (1) from October 1 through April 30 of each year, in addition to the amount allowed in 17 AAC 25.013, an additional 1,500-pound allowance will be granted for snow and ice build-up, if evidence of that build-up exists; this allowance is the maximum allowance regardless of the make-up of the vehicle combinations;
- (2) whenever the department finds a violation, it will give a warning, issue the driver of the vehicle a citation, or inspect the vehicle, and
- (3) if the vehicle gross weight is over the amount allowed in 17 AAC 25.013 and paragraph (1) of this subsection by more than 1,000 pounds, the vehicle will directed to a location to unload the excess weight from the vehicle.

(c) The following procedures will be observed while enforcing the axle group weight requirements set out in 17 AAC 25.013:

- (1) whenever the department finds a violation, it will give a warning, may issue the driver of the vehicle a citation, or may inspect the vehicle and note the violation on the inspection form;
- (2) if the weight of an axle group on a vehicle is over the amount allowed in 17 AAC 25.013 by more than 1,000 pounds, but no more than 2,000 pounds, and can be corrected at the weigh station by shifting the load, the load must be corrected by shifting before the vehicle will be allowed to proceed;
- (3) if the weight of an axle group on a vehicle is over the amount allowed in 17 AAC 25.013 by more than 1,000 pounds but no more than 2,000 pounds and cannot be corrected at the weigh station by shifting the load, the driver of the vehicle will be directed to a location to unload the excess weight from the vehicle;
- (4) if the weight of an axle group on a vehicle is over the amount allowed in 17 AAC 25.013 by more than 2,000 pounds, the driver of the vehicle will be directed to a location to unload the excess weight from the vehicle; however, if the weight of that axle group is over the legally allowed amount by more than 125 percent of the legally allowed amount and cannot be corrected by shifting the load, the driver may be directed to park the vehicle at the weigh station or enforcement site until the vehicle's weight can be reduced to within the amount allowed in 17 AAC 25.013 or until a permit under 17 AAC 25.320 is obtained.
- (5) if the weight of an axle group on a vehicle is over the amount allowed in 17 AAC 25.013 by more than 2,000 pounds, the driver of the vehicle will be issued a citation for the violation and be directed to a location to unload the excess weight from the vehicle; however, if the weight of that axle group is over the legally allowed amount by more than 125 percent of the legally allowed amount and cannot be corrected by shifting the load, the vehicle will be parked at the weigh station or enforcement site until the vehicle's weight can be reduced to within the amount allowed in 17 AAC 25.013 or in a permit issued under 17 AAC 25.320.

Eff. 10/7/2001, Register 160; am 4/9/2009, Register 190; am 12/30/2010, Register 196; am 12/6/2018, Register 228, January 2019

AAC Title 17 Chapter 35.020 - Industrial use highway permits

(a) A vehicle whose length exceeds the limitations of 17 AAC 25 but whose length is not more than 90 feet, including load, or whose weight exceeds the gross vehicle weight limitations of 17 AAC 25.060 but whose gross vehicle weight is not more than 200,000 pounds, will, in the department's discretion, be issued an industrial use highway permit to operate on an industrial use highway if the length and weight do not exceed those specified by the department for the industrial use highway.

(b) Subject to (c) of this section, an overweight or oversize permit referred to in 17 AAC 25.010, and issued under 3 AAC 35, is not required for a vehicle for which an industrial use highway permit has been issued under 17 AAC 35.030.

(c) A vehicle whose gross vehicle weight or whose length exceeds the weight or length limits specified for a particular industrial use highway may not operate on that industrial use highway unless it has a valid overweight or oversize permit issued under 3 AAC 35 and the permit fee, as calculated under 17 AAC 35.050, has been paid.

(d) A vehicle used on an industrial use highway which has neither an industrial use highway permit nor an overweight or oversize permit issued under 3 AAC 35, is subject to the weight and size limitations of 17 AAC 25.010(a).

(e) Application for an industrial use highway permit for a single trip must be made at least 24 hours before the applicant intends to move the vehicle on the highway. Application for an industrial use highway permit allowing multiple movements must be made at least 14 days before the applicant intends to commence operations. A permit will not be issued until the department has reviewed the permit application. In reviewing the permit application, the department will, in its discretion, conduct extensive analyses and will, in its discretion, solicit public comment.

(f) A permit application form may be obtained at the department office designated for the specific industrial use highway, and a completed application must be submitted to the department. However, if the commissioner has delegated authority to issue industrial use highway permits to another state agency under 17 AAC 35.030(f), a permit application form may also be obtained from that state agency and the completed application must be submitted to that state agency as described in (e) of this section rather than to the department.

Eff. 11/1/87, Register 104; am 7/3/91, Register 119

AAC Title 17 Chapter 35.050 - Industrial use highway permit fees

(a) The department will charge a non-refundable fee for an industrial use highway permit issued under 17 AAC 35.030. The permit fee is calculated to offset the costs to the state to keep the roadway surface and other structures, including bridges, in a condition to accommodate long or heavy loads, and to offset administrative costs related to issuing industrial use highway permits. The permit fee will be calculated under (b) or (c) of this section, as applicable.

(b) A single-trip permit fee, based upon the criteria set out in (a) of this section, will be determined and set for each industrial use highway at least once each year and will be calculated on the basis of each vehicle Equivalent Axle Load (EAL). In the department's discretion, a single-trip permit fee will be determined and set more than once each year. The single-trip permit fee is calculated as follows:

(1) Equivalent Axle Load (EAL) is calculated using the following formula, which is derived from B.A. Anani and M.C. Wang, State of the Art Review on Equivalent Axle Loading for Pavement Design, Report PTI 7803, Pennsylvania Transportation Institute, Pennsylvania State University (March, 1978): 4.79 EAL for Single Axle = $[\text{Axle Weight (pounds)} / 1000] + 1.18 + 14.79$ EAL for a Tandem Axle = $[\text{Axle Group Weight (pounds)} / 1000] + 1.32 + 14.79$ EAL for a Three Axle Tandem = $[\text{Axle Group Weight (pounds)} / 1000] + 1.40 + 1$

(2) The permit fee is calculated by multiplying the sum of EAL values calculated under (1) of this subsection for each axle or axle group of the vehicle, by the dollar amount set for an EAL for that industrial use highway.

(c) The fee for a multiple movement permit is calculated as for a single-trip permit fee, and applied to each movement authorized under the multiple movement permit.

(d) The single-trip permit fee must be paid to the department as a condition of issuance. A billing system may be established by the department for multiple movements of equivalent weights by one individual, firm or company, provided evidence of a good credit rating has been supplied by the individual, firm or company. Payment must be in a form acceptable to the department.

(e) For purposes of this section, "administrative costs" include expenses associated with vehicle and load inspection, bridge and pavement design review, route inspection and monitoring, and billing costs.

Eff. 11/1/87, Register 104

AAC Title 17 Chapter 35.200 - The Klondike Highway

(a) The Klondike Highway from Skagway to the Canadian Border is designated as an industrial use highway. A vehicle that exceeds the weight or length limitations of 17 AAC 25, but whose gross vehicle weight is not more than 170,000 pounds and whose length does not exceed 85 feet will, in the department's discretion, be issued an industrial use highway permit for operations on this route.

(b) The single-trip permit fee for the Klondike Highway is \$3.95 per equivalent axle load (EAL) as determined under 17 AAC 35.050(b).

(c) An industrial use highway permit application for vehicular operations on the Klondike Highway may be obtained at the department's maintenance and operations offices in Skagway or Juneau.

Eff. 11/1/87, Register 104; am 7/3/91, Register 119

Appendix C: Characteristics of Alaska WIM Data Classification Scheme

Appendix C

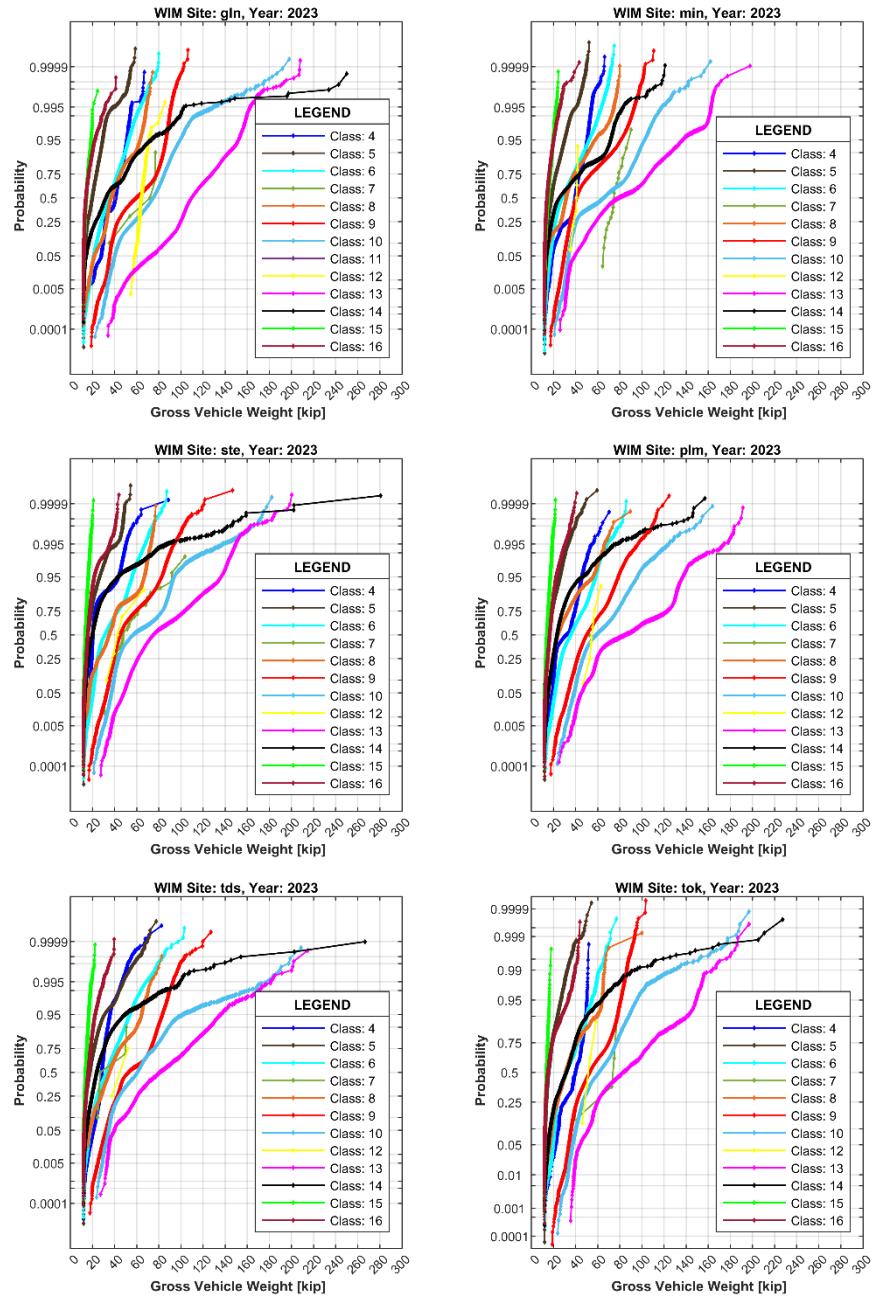


Figure- C-1: Gross Vehicle Weight distribution by WIM classification scheme.

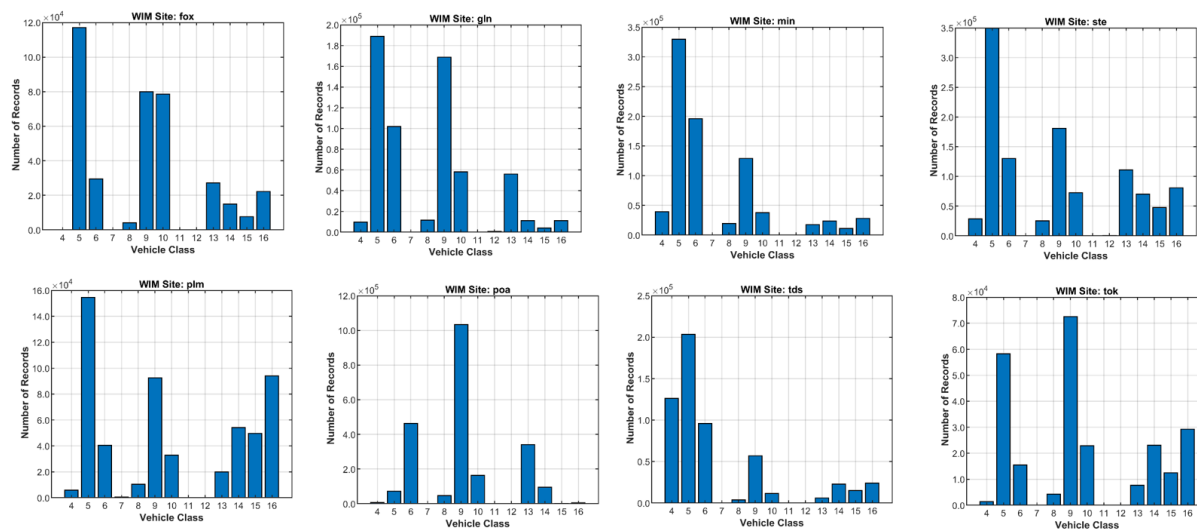


Figure- C-2: Alaska vehicle class distribution for WIM classification scheme.

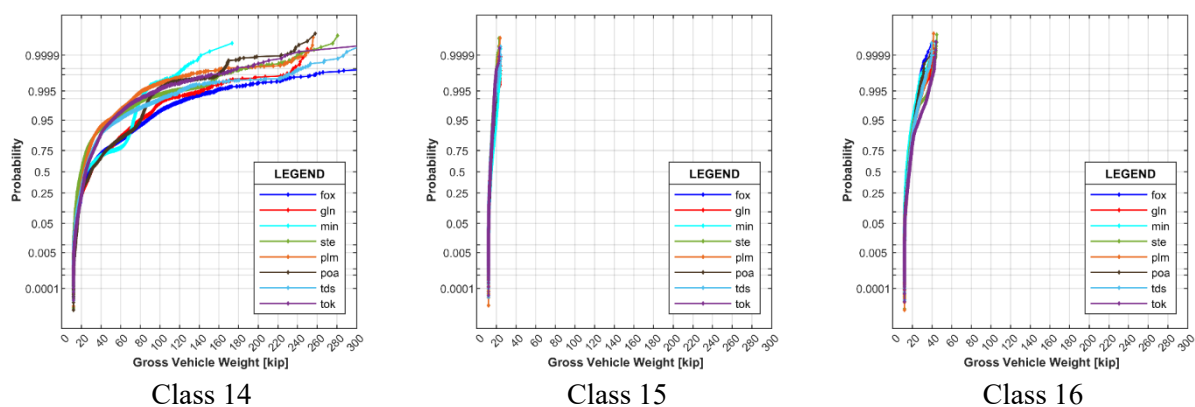


Figure- C-3: Gross Vehicle Weight distribution for WIM classes 14, 15, and 16.

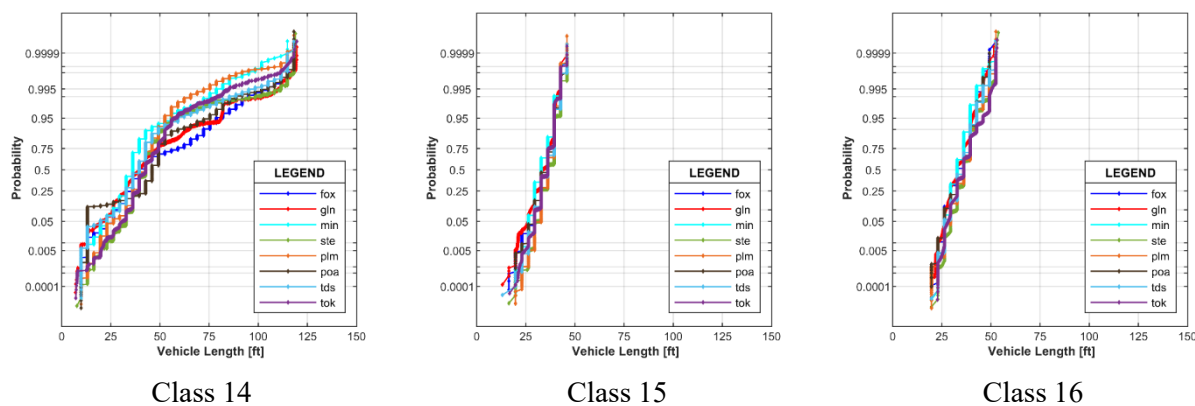


Figure- C-4: Vehicle Length distribution for WIM classes 14, 15, and 16.

Appendix D: WIM Quality Control Results by WIM site and year.

Appendix D

Table- D-1: Quality Control Summary for fox WIM site

WIM Site	1	fox	Steese Highway WIM (FOX)																
	Year	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Number of records after QC filtering	Number of all records
		Invalid Month	Invalid Day	Zero GVW	Zero Axle Weight	Zero Spacing	Axle Weight < 2kip	Axle Weight > 45kip	1st Axle Weight > 35kip	GVW +/- 10%	GVW < 12 kips	Axle Spacing < 3.2 ft	Axle Spacing > 50 ft	1st Axle Spacing < 6 ft	Total length < 7 ft	Total length > 120 ft	Any		
1	2015	0%	0%	0%	0%	0%	3%	0%	0%	0%	43%	0%	0%	0%	0%	0%	44%	114,702	205,289
1	2016	0%	0%	0%	0%	0%	10%	0%	0%	0%	49%	0%	0%	0%	0%	0%	53%	86,525	185,033
1	2017	0%	0%	0%	0%	0%	9%	0%	0%	0%	50%	0%	0%	0%	0%	0%	54%	86,737	187,702
1	2018	0%	0%	0%	0%	0%	14%	0%	0%	0%	46%	0%	1%	1%	0%	0%	54%	93,456	204,949
1	2019	0%	0%	0%	0%	0%	10%	0%	0%	0%	44%	7%	1%	1%	0%	0%	52%	92,734	192,523
1	2020	0%	0%	0%	0%	0%	16%	0%	0%	0%	58%	10%	0%	1%	0%	0%	65%	60,696	172,588
1	2021	0%	0%	0%	0%	0%	15%	0%	0%	0%	59%	9%	0%	0%	0%	0%	66%	59,050	174,152
1	2022	0%	0%	1%	1%	1%	11%	0%	0%	0%	53%	8%	0%	0%	0%	0%	60%	68,330	170,241
1	2023	0%	0%	0%	0%	0%	11%	0%	0%	0%	49%	9%	0%	2%	0%	0%	57%	64,527	149,264

Table- D-2: Quality Control Summary for gln WIM site

WIM Site	2	gln	Glenn Highway (Scalehouse)																
	Year	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Number of records after QC filtering	Number of all records
		Invalid Month	Invalid Day	Zero GVW	Zero Axle Weight	Zero Spacing	Axle Weight < 2kip	Axle Weight > 45kip	1st Axle Weight > 35kip	GVW +/- 10%	GVW < 12 kips	Axle Spacing < 3.2 ft	Axle Spacing > 50 ft	1st Axle Spacing < 6 ft	Total length < 7 ft	Total length > 120 ft	Any		
2	2020	0%	0%	75%	75%	0%	4%	0%	0%	0%	83%	2%	0%	0%	0%	0%	84%	211,122	1,329,662
2	2021	0%	0%	76%	76%	0%	4%	0%	0%	0%	85%	14%	0%	0%	0%	0%	86%	234,680	1,670,334
2	2022	0%	0%	76%	76%	0%	3%	0%	0%	0%	83%	10%	0%	0%	0%	0%	84%	42,668	262,998
2	2023	0%	0%	77%	77%	0%	3%	0%	0%	0%	84%	12%	0%	1%	0%	0%	85%	133,384	901,173

Table- D-3: Quality Control Summary for min WIM site

WIM Site	3	min	Minnesota Drive south of International Airport Road																
	Year	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Number of records after QC filtering	Number of all records
		Invalid Month	Invalid Day	Zero GVW	Zero Axle Weight	Zero Spacing	Axle Weight < 2kip	Axle Weight > 45kip	1st Axle Weight > 35kip	GVW +/- 10%	GVW < 12 kips	Axle Spacing < 3.2 ft	Axle Spacing > 50 ft	1st Axle Spacing < 6 ft	Total length < 7 ft	Total length > 120 ft	Any		
3	2020	0%	0%	0%	0%	0%	9%	0%	0%	0%	50%	0%	0%	1%	1%	0%	52%	150,157	310,785
3	2021	0%	0%	0%	0%	0%	8%	0%	0%	0%	52%	0%	0%	1%	1%	0%	54%	205,194	441,531
3	2022	0%	0%	0%	0%	0%	7%	0%	0%	0%	48%	0%	0%	1%	1%	0%	50%	236,247	472,360
3	2023	0%	0%	0%	0%	0%	7%	0%	0%	0%	47%	0%	0%	1%	1%	0%	48%	240,131	465,802

Table- D-4: Quality Control Summary for ste WIM site

WIM Site	4	ste	Sterling Hwy Btwn Lake Terrace Dr and Secret Rd																
	Year	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Number of records after QC filtering	Number of all records
		Invalid Month	Invalid Day	Zero GVW	Zero Axle Weight	Zero Spacing	Axle Weight < 2kip	Axle Weight > 45kip	1st Axle Weight > 35kip	GVW +/- 10%	GVW < 12 kips	Axle Spacing < 3.2 ft	Axle Spacing > 50 ft	1st Axle Spacing < 6 ft	Total length < 7 ft	Total length > 120 ft	Any		
4	2015	0%	0%	0%	0%	0%	25%	0%	0%	0%	60%	0%	0%	1%	0%	0%	65%	18,410	52,154
4	2016	0%	0%	0%	0%	0%	20%	0%	0%	0%	57%	0%	0%	0%	0%	0%	61%	132,556	335,668
4	2017	0%	0%	0%	0%	0%	19%	0%	0%	0%	60%	7%	0%	0%	0%	0%	66%	117,843	343,286
4	2018	0%	0%	0%	0%	0%	19%	0%	0%	0%	59%	14%	0%	0%	0%	0%	68%	115,436	365,268
4	2019	0%	0%	0%	0%	0%	18%	0%	0%	0%	55%	0%	0%	0%	0%	0%	59%	148,866	365,548
4	2020	0%	0%	0%	0%	0%	24%	0%	0%	0%	61%	0%	0%	0%	0%	0%	66%	107,404	311,870
4	2021	0%	0%	0%	0%	0%	21%	0%	0%	0%	61%	0%	0%	0%	0%	0%	64%	137,088	385,424
4	2022	0%	0%	0%	0%	0%	19%	0%	0%	0%	54%	0%	0%	0%	0%	0%	59%	163,123	394,532
4	2023	0%	0%	0%	0%	0%	20%	0%	0%	0%	57%	0%	0%	0%	0%	0%	62%	156,933	409,809

Table- D-5: Quality Control Summary for plm WIM site

WIM Site	6	plm	Glenn Highway at MP 53																
	Year	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Number of records after QC filtering	Number of all records
		Invalid Month	Invalid Day	Zero GVW	Zero Axle Weight	Zero Spacing	Axle Weight < 2kip	Axle Weight > 45kip	1st Axle Weight > 35kip	GVW +/- 10%	GVW < 12 kips	Axle Spacing < 3.2 ft	Axle Spacing > 50 ft	1st Axle Spacing < 6 ft	Total length < 7 ft	Total length > 120 ft	Any		
6	2015	0%	0%	0%	0%	0%	26%	0%	0%	0%	54%	0%	0%	0%	0%	0%	59%	19,414	47,113
6	2016	0%	0%	0%	0%	0%	31%	0%	0%	0%	48%	0%	0%	5%	0%	0%	59%	83,124	201,590
6	2017	0%	0%	0%	0%	0%	29%	0%	0%	0%	53%	0%	0%	0%	0%	0%	60%	57,780	143,443
6	2018	0%	0%	0%	0%	0%	33%	0%	0%	0%	65%	0%	0%	1%	0%	0%	68%	2,196	6,842
6	2019	0%	0%	0%	0%	0%	24%	0%	0%	0%	47%	0%	0%	2%	1%	0%	54%	80,993	175,969
6	2020	0%	0%	0%	0%	0%	28%	0%	0%	0%	53%	0%	1%	5%	5%	0%	60%	63,059	158,924
6	2021	0%	0%	0%	0%	0%	27%	0%	0%	0%	57%	0%	0%	0%	0%	0%	62%	71,362	188,763
6	2022	0%	0%	0%	0%	0%	23%	0%	0%	0%	46%	0%	0%	2%	0%	0%	54%	88,818	192,912
6	2023	0%	0%	0%	0%	0%	25%	0%	0%	0%	48%	0%	0%	1%	1%	0%	57%	87,882	203,314

Table- D-6: Quality Control Summary for poa WIM site

WIM Site	7	poa	Ocean Dock (Port of Anchorage)																
	Year	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Number of records after QC filtering	Number of all records
		Invalid Month	Invalid Day	Zero GVW	Zero Axle Weight	Zero Spacing	Axle Weight < 2kip	Axle Weight > 45kip	1st Axle Weight > 35kip	GVW +/- 10%	GVW < 12 kips	Axle Spacing < 3.2 ft	Axle Spacing > 50 ft	1st Axle Spacing < 6 ft	Total length < 7 ft	Total length > 120 ft	Any		
7	2015	0%	0%	0%	0%	0%	15%	0%	0%	0%	32%	0%	0%	0%	0%	1%	34%	103,270	156,269
7	2016	0%	0%	0%	0%	0%	7%	0%	0%	0%	15%	0%	0%	0%	0%	0%	17%	305,484	366,337
7	2017	0%	0%	0%	0%	0%	2%	0%	0%	0%	8%	0%	0%	0%	0%	0%	10%	313,092	348,740
7	2018	0%	0%	0%	0%	0%	4%	0%	0%	0%	9%	0%	0%	0%	0%	0%	11%	315,056	355,601
7	2019	0%	0%	0%	0%	0%	13%	0%	0%	0%	5%	0%	0%	0%	0%	0%	16%	109	129
7	2020	0%	0%	0%	0%	0%	1%	0%	0%	0%	7%	0%	0%	0%	0%	0%	8%	228,311	246,831
7	2021	0%	0%	0%	0%	0%	1%	0%	0%	0%	7%	0%	0%	0%	0%	0%	8%	327,695	354,392
7	2022	0%	0%	0%	0%	0%	1%	0%	0%	0%	6%	0%	0%	0%	0%	0%	7%	338,060	363,494
7	2023	0%	0%	0%	0%	0%	3%	0%	0%	0%	8%	0%	1%	0%	0%	0%	10%	297,325	329,908

Table- D-7: Quality Control Summary for tds WIM site

WIM Site	tds	Tudor Road btwn Patterson St and Kingston Rd																	
	Year	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Number of records after QC filtering	Number of all records
		Invalid Month	Invalid Day	Zero GVW	Zero Axle Weight	Zero Spacing	Axle Weight < 2kip	Axle Weight > 45kip	1st Axle Weight > 35kip	GVW +/- 10%	GVW < 12 kips	Axle Spacing < 3.2 ft	Axle Spacing > 50 ft	1st Axle Spacing < 6 ft	Total length < 7 ft	Total length > 120 ft	Any		
8	2020	0%	0%	0%	0%	0%	15%	0%	0%	0%	50%	0%	1%	0%	0%	0%	53%	113,221	239,128
8	2021	0%	0%	0%	0%	0%	12%	0%	0%	0%	53%	0%	0%	1%	0%	0%	55%	156,811	348,172
8	2022	0%	0%	0%	0%	0%	17%	0%	0%	0%	50%	0%	0%	5%	0%	0%	53%	148,117	316,989
8	2023	0%	0%	0%	0%	0%	10%	0%	0%	0%	47%	0%	0%	0%	0%	0%	49%	147,351	288,420

Table- D-8: Quality Control Summary for tok WIM site

WIM Site	9	plm	Glenn Highway at MP 53																
	Year	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Number of records after QC filtering	Number of all records
		Invalid Month	Invalid Day	Zero GVW	Zero Axle Weight	Zero Spacing	Axle Weight < 2kip	Axle Weight > 45kip	1st Axle Weight > 35kip	GVW +/- 10%	GVW < 12 kips	Axle Spacing < 3.2 ft	Axle Spacing > 50 ft	1st Axle Spacing < 6 ft	Total length < 7 ft	Total length > 120 ft	Any		
9	2015	0%	0%	0%	0%	0%	13%	0%	0%	0%	35%	0%	0%	0%	0%	0%	41%	9,085	15,412
9	2016	0%	0%	0%	0%	0%	15%	0%	0%	0%	37%	0%	0%	1%	0%	0%	44%	38,948	69,926
9	2017	0%	0%	0%	0%	0%	17%	0%	0%	0%	39%	0%	0%	1%	0%	0%	47%	27,322	51,393
9	2018	0%	0%	0%	0%	0%	15%	0%	0%	0%	32%	0%	0%	1%	0%	0%	41%	40,939	69,127
9	2019	0%	0%	0%	0%	0%	12%	0%	0%	0%	32%	23%	0%	2%	0%	0%	57%	31,758	73,514
9	2020	0%	0%	0%	0%	0%	9%	0%	0%	0%	31%	20%	0%	1%	0%	0%	51%	21,666	44,414
9	2021	0%	0%	0%	0%	0%	9%	0%	0%	0%	37%	21%	0%	1%	0%	0%	57%	21,314	49,267
9	2022	0%	0%	0%	0%	0%	12%	0%	0%	0%	38%	24%	0%	1%	0%	0%	60%	25,159	62,854
9	2023	0%	0%	0%	0%	0%	12%	0%	0%	0%	44%	21%	0%	0%	0%	0%	64%	31,139	85,367

Appendix E: Alaska Long Combination Vehicle Routes

Appendix E

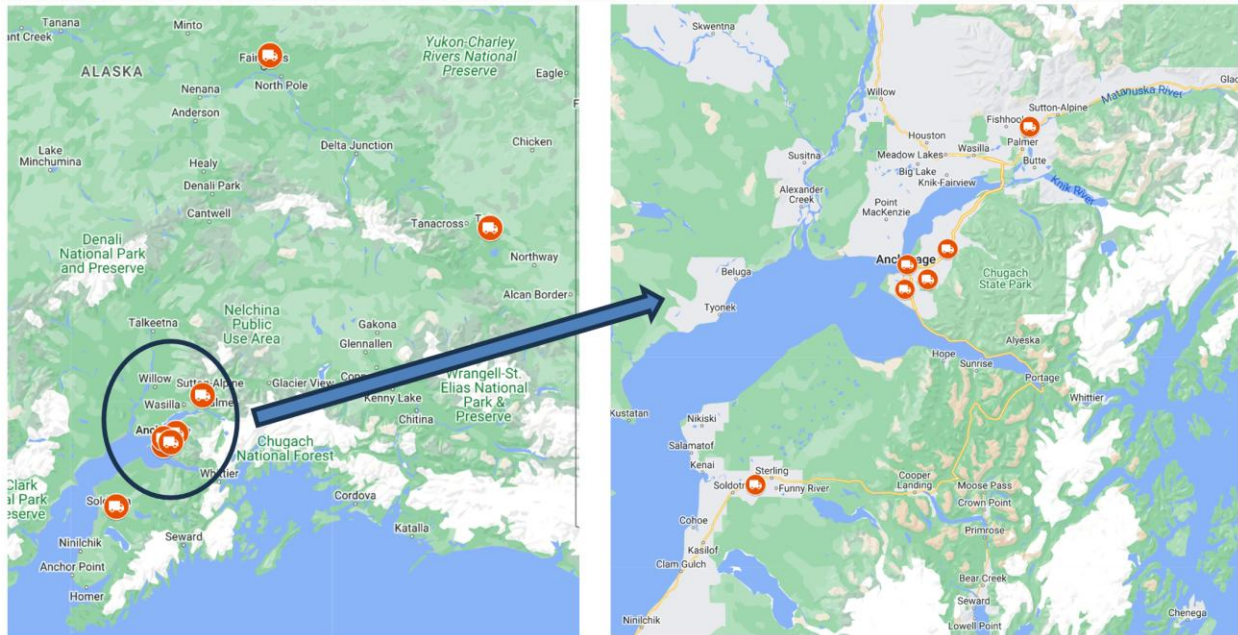


Figure- E-1: Alaska WIM site locations

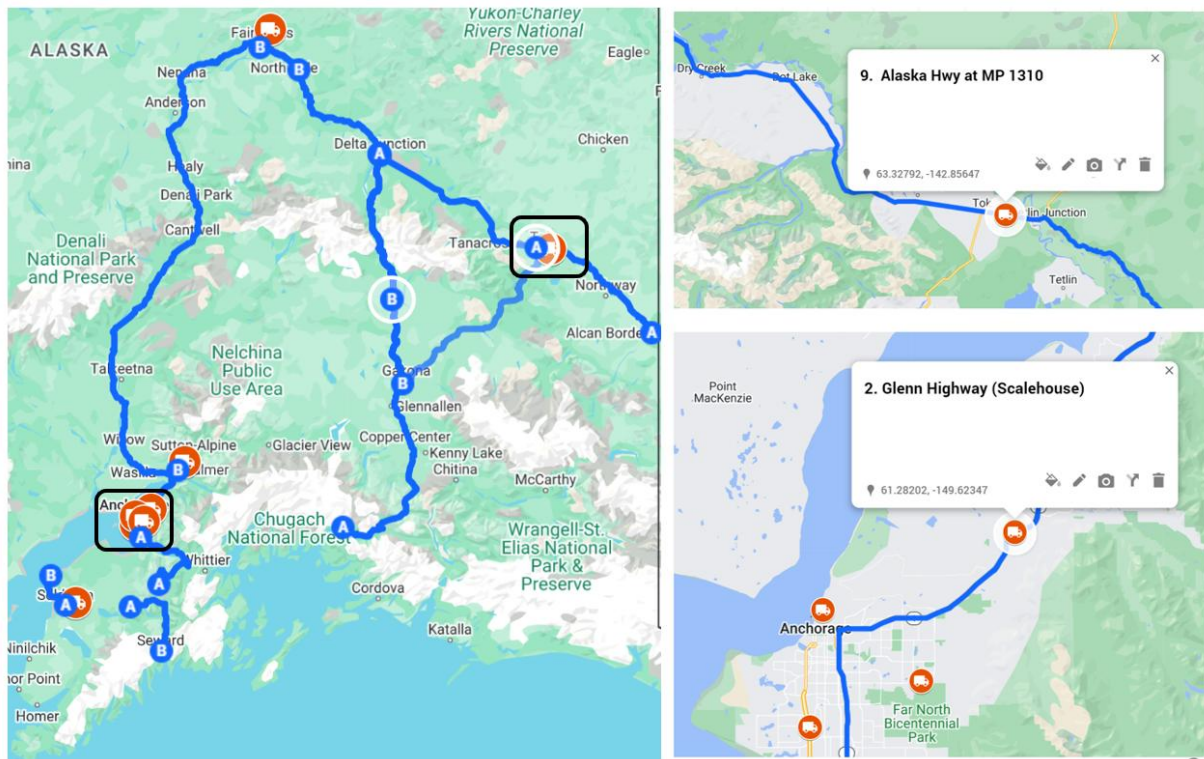


Figure- E-2: AAC 25.014 Long Combination Vehicle Length section (a)

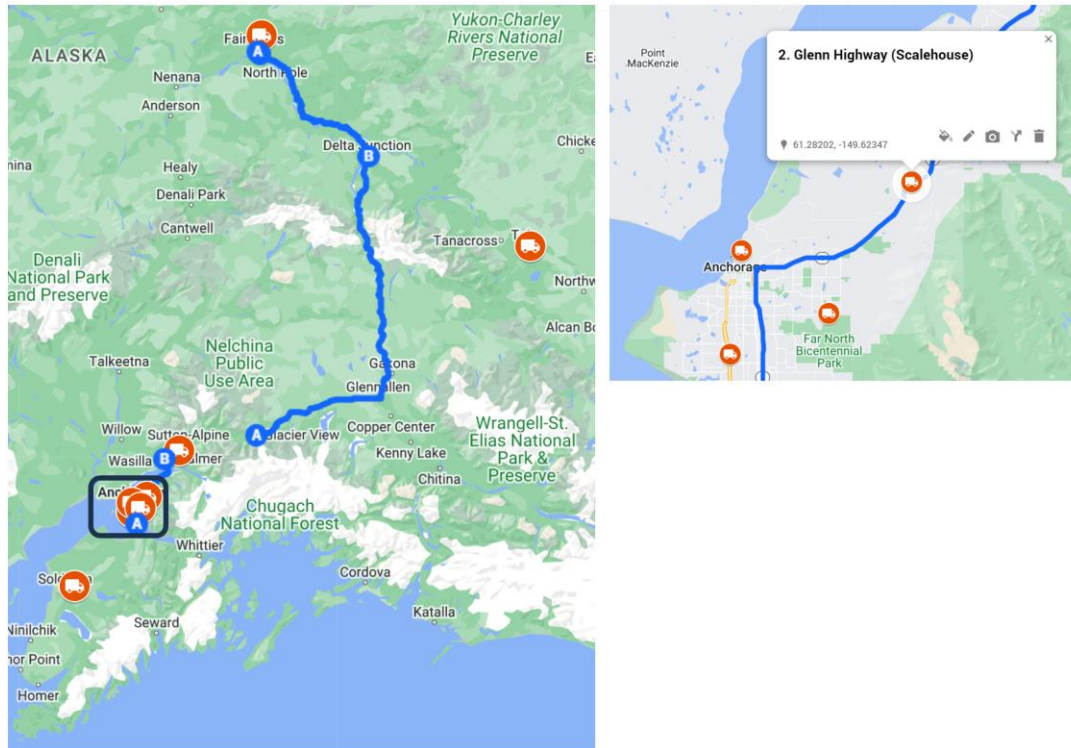


Figure- E-3: AAC 25.014 Long Combination Vehicle Length section (b)

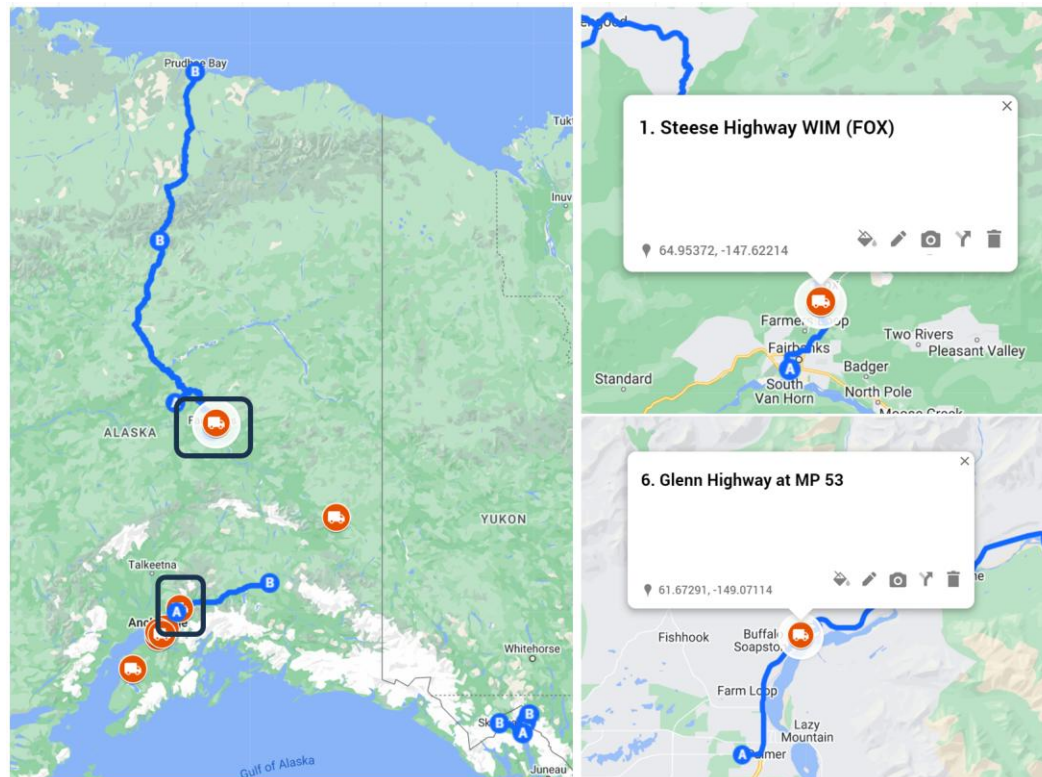


Figure- E-4: AAC 25.014 Long Combination Vehicle Length section (c)

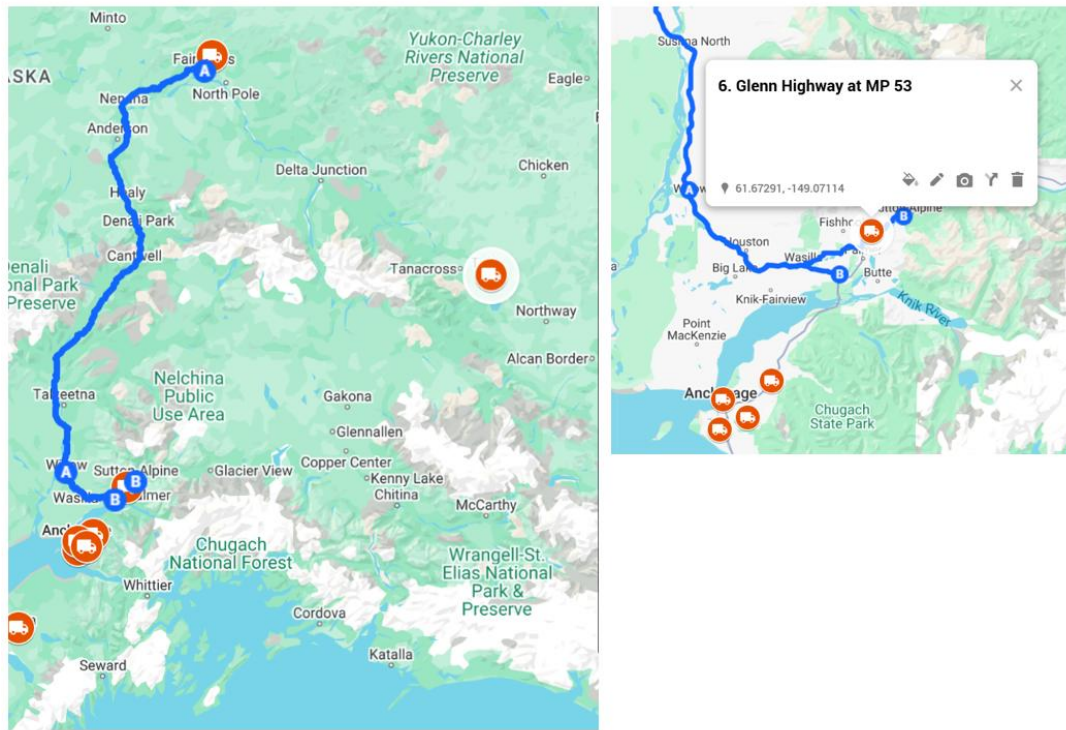


Figure- E-5: AAC 25.014 Long Combination Vehicle Length section (d) under issued permit.

Appendix F: Gross Vehicle Weight Statistics

Appendix F

Table- F-1: GVW statistics for Alaska Legal Traffic

WIM ID	WIM Site	Year	Number of WIM Records	Percentage					Number of Records				
				GVW > 80 kip	GVW > 100 kip	GVW > 120 kip	GVW > 140 kip	GVW > 160 kip	GVW > 80 kip	GVW > 100 kip	GVW > 120 kip	GVW > 140 kip	GVW > 160 kip
1	fox	2022	55,369	10.83%	2.85%	0.57%	0.00%	0.00%	5,996	1,577	318	1	0
2	gln	2023	111,225	6.98%	0.53%	0.00%	0.00%	0.00%	7,766	585	0	0	0
3	min	2023	207,581	0.94%	0.05%	0.00%	0.00%	0.00%	1,950	105	0	0	0
4	ste	2023	115,856	2.18%	0.10%	0.01%	0.00%	0.00%	2,529	111	6	5	0
6	plm	2023	59,956	2.56%	0.64%	0.34%	0.00%	0.00%	1,536	384	205	0	0
7	poa	2022	291,021	6.27%	2.81%	0.00%	0.00%	0.00%	18,245	8,166	0	0	0
8	tds	2023	120,208	0.68%	0.00%	0.00%	0.00%	0.00%	814	3	0	0	0
9	tok	2023	26,945	3.64%	0.09%	0.00%	0.00%	0.00%	981	23	0	0	0
Total/Avg:			988,161	4.26%	0.88%	0.12%	0.00%	0.00%	39,817	10,954	529	6	0

Table- F-2: GVW statistics for Alaska Legal and Routine Permit Traffic

WIM ID	WIM Site	Year	Number of WIM Records	Percentage					Number of Records				
				GVW > 80 kip	GVW > 100 kip	GVW > 120 kip	GVW > 140 kip	GVW > 160 kip	GVW > 80 kip	GVW > 100 kip	GVW > 120 kip	GVW > 140 kip	GVW > 160 kip
1	fox	2022	66,489	20.90%	9.01%	0.66%	0.04%	0.00%	13,897	5,993	438	24	0
2	gln	2023	127,740	16.44%	6.12%	2.57%	0.89%	0.05%	20,995	7,815	3,281	1,131	64
3	min	2023	227,674	3.24%	0.98%	0.24%	0.07%	0.03%	7,376	2,225	538	152	70
4	ste	2023	134,468	7.61%	2.80%	1.12%	0.27%	0.00%	10,234	3,765	1,512	367	0
6	plm	2023	62,961	4.53%	1.95%	1.27%	0.08%	0.00%	2,853	1,225	801	49	1
7	poa	2022	334,295	13.32%	7.12%	1.39%	0.58%	0.03%	44,530	23,818	4,639	1,929	85
8	tds	2023	134,721	1.90%	0.38%	0.12%	0.01%	0.00%	2,554	516	155	13	1
9	tok	2023	29,115	6.71%	1.50%	0.60%	0.37%	0.00%	1,953	438	174	108	0
Total/Avg:			1,117,463	9.30%	3.70%	1.00%	0.30%	0.00%	104,392	45,795	11,538	3,773	221

Table- F-3: GVW statistics for Alaska Routine Permit Traffic

WIM ID	WIM Site	Year	Number of WIM Records	Percentage					Number of Records				
				GVW > 80 kip	GVW > 100 kip	GVW > 120 kip	GVW > 140 kip	GVW > 160 kip	GVW > 80 kip	GVW > 100 kip	GVW > 120 kip	GVW > 140 kip	GVW > 160 kip
1	fox	2022	11,120	71.05%	39.71%	1.08%	0.21%	0.00%	7,901	4,416	120	23	0
2	gln	2023	16,515	80.10%	43.78%	19.87%	6.85%	0.39%	13,229	7,230	3,281	1,131	64
3	min	2023	20,093	27.00%	10.55%	2.68%	0.76%	0.35%	5,426	2,120	538	152	70
4	ste	2023	18,612	41.40%	19.63%	8.09%	1.94%	0.00%	7,705	3,654	1,506	362	0
6	plm	2023	3,005	43.83%	27.99%	19.83%	1.63%	0.03%	1,317	841	596	49	1
7	poa	2022	43,274	60.74%	36.17%	10.72%	4.46%	0.20%	26,285	15,652	4,639	1,929	85
8	tds	2023	14,513	11.99%	3.53%	1.07%	0.09%	0.01%	1,740	513	155	13	1
9	tok	2023	2,170	44.79%	19.12%	8.02%	4.98%	0.00%	972	415	174	108	0
Total/Avg:			129,302	47.61%	25.06%	8.92%	2.61%	0.12%	64,575	34,841	11,009	3,767	221

Appendix G: WIM Live Load Force Effects

Appendix G

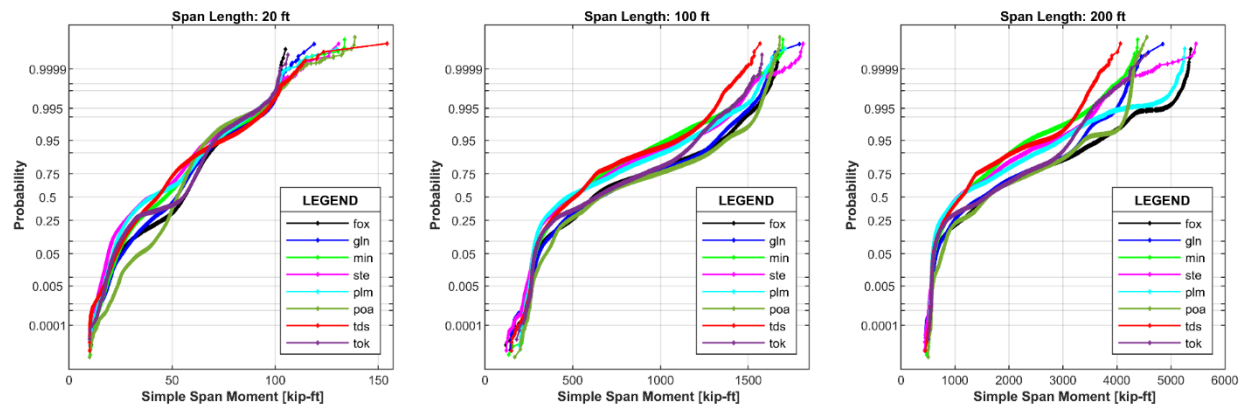


Figure- G-1: Simple Span Moment (M11) for short, medium, and long bridges.

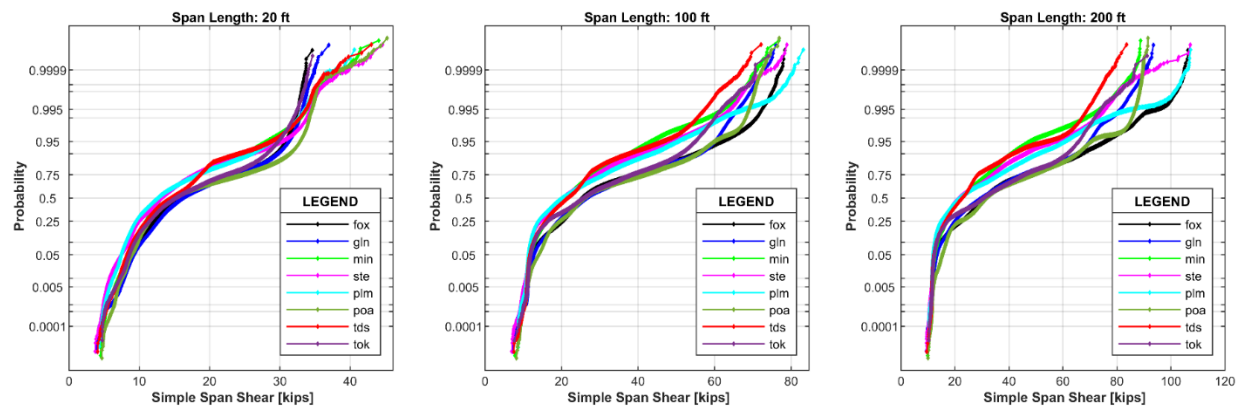


Figure- G-2: Simple Span Shear (S1) for short, medium, and long bridges.

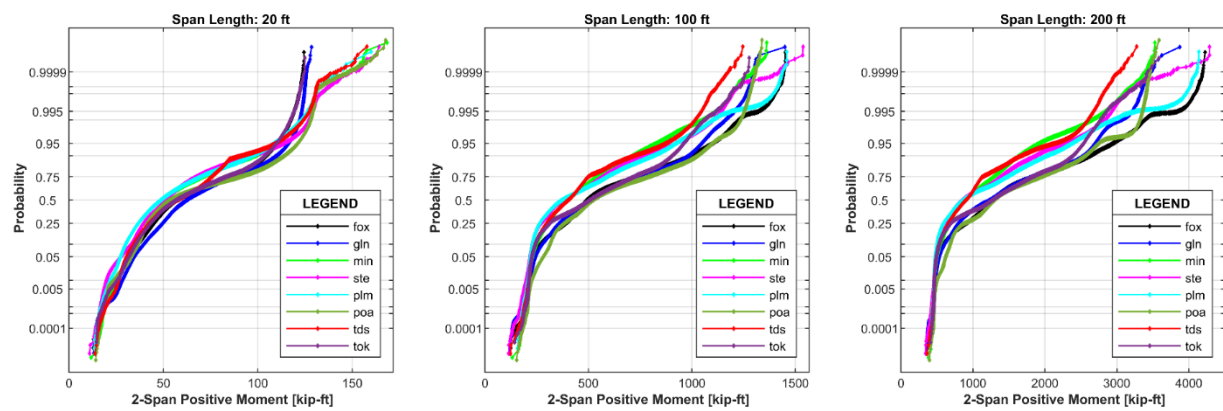


Figure- G-3: Span Cont. Positive Moment (M21) for short, medium, and long bridges.

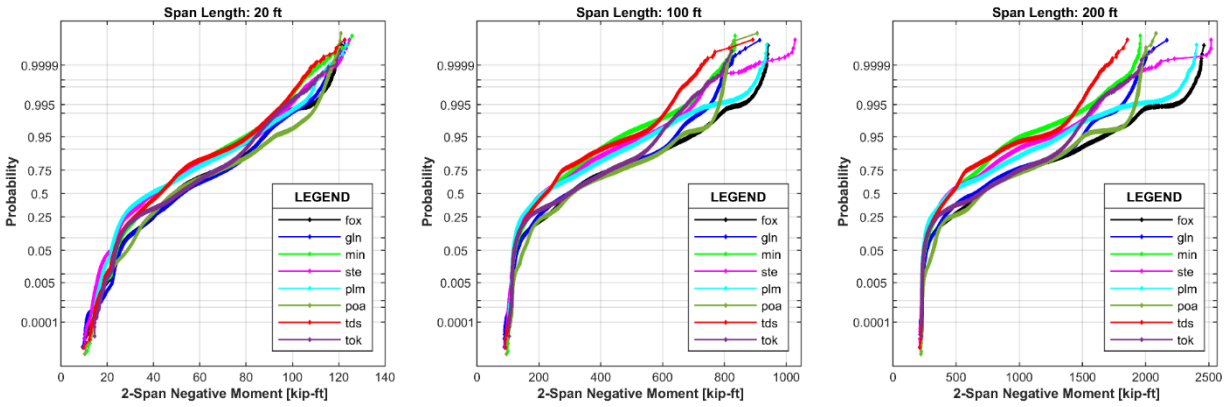


Figure- G-4: Span Cont. Negative Moment (M22) for short, medium, and long bridges.

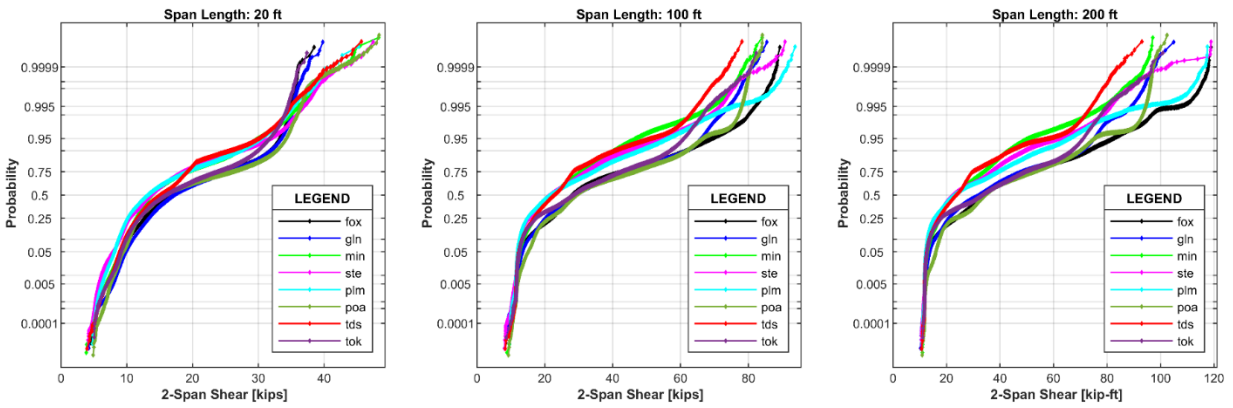


Figure- G-5: Span Cont. Shear (S2) for short, medium, and long bridges.

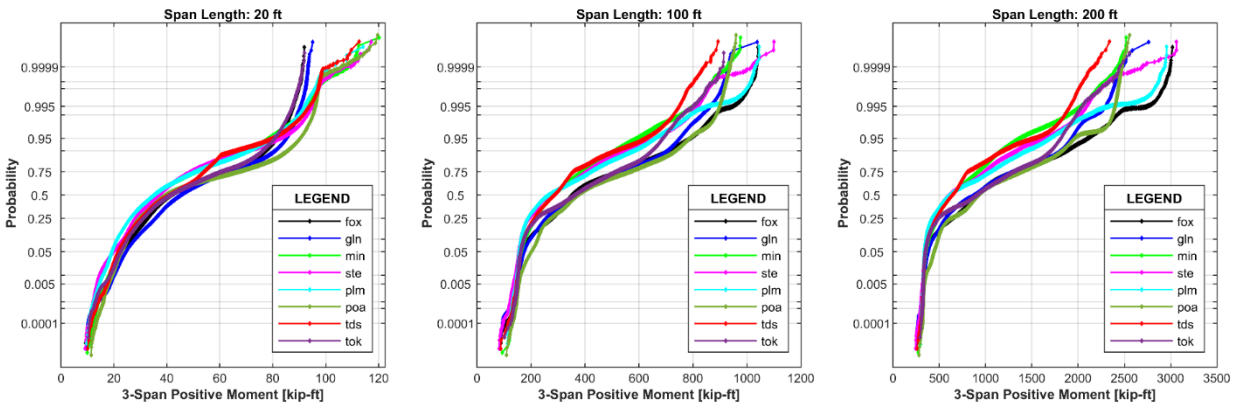


Figure- G-6: Span Cont. Positive Moment (M31) for short, medium, and long bridges.

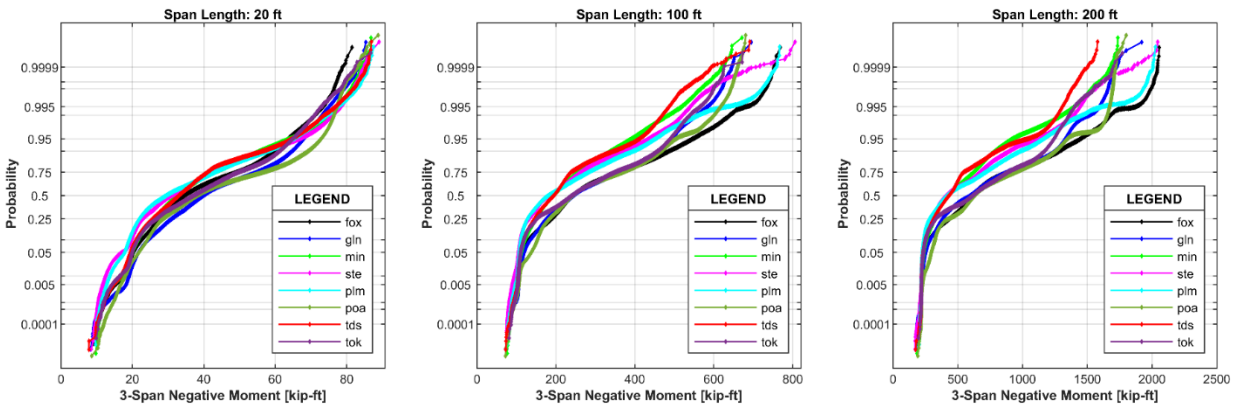


Figure- G-7: Span Cont. Negative Moment (M32) for short, medium, and long bridges.

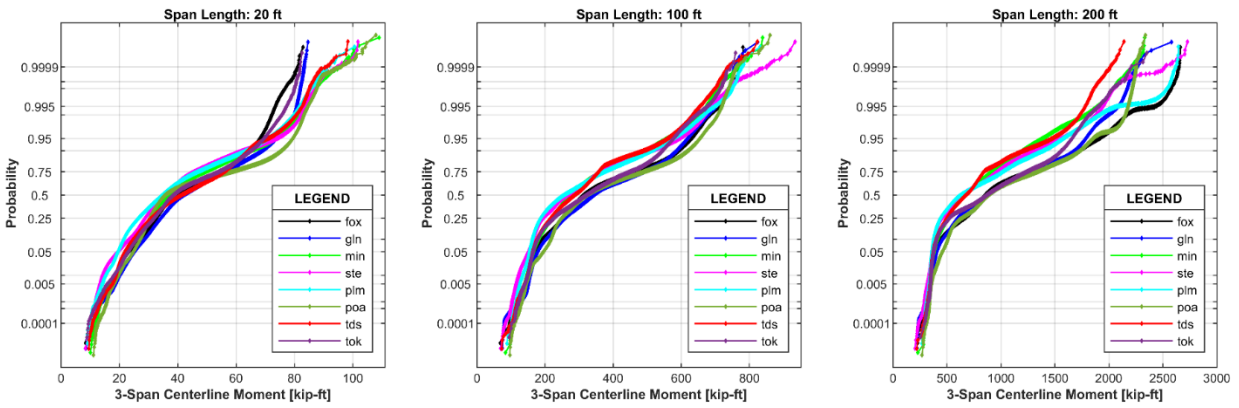


Figure- G-8: Span Cont. Centerline Moment (M33) for short, medium, and long bridges.

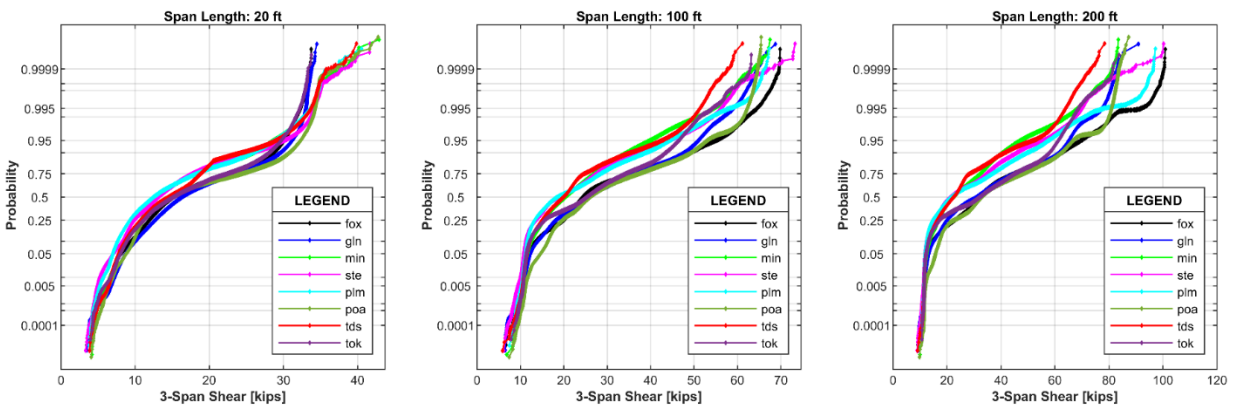


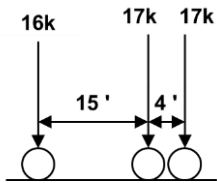
Figure- G-9: Span Cont. Shear (S3) for short, medium, and long bridges.

Appendix H: AASHTO MBE Legal Rating Trucks Configurations

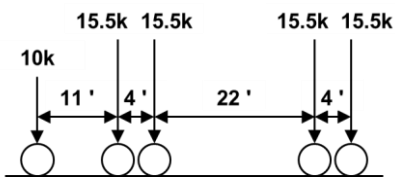
Appendix H

AASHTO Legal Loads (Truck & Lane-Type)

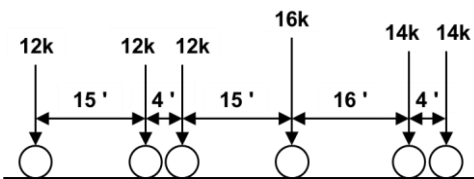
Type 3



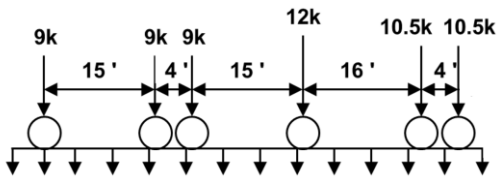
Type 3S2



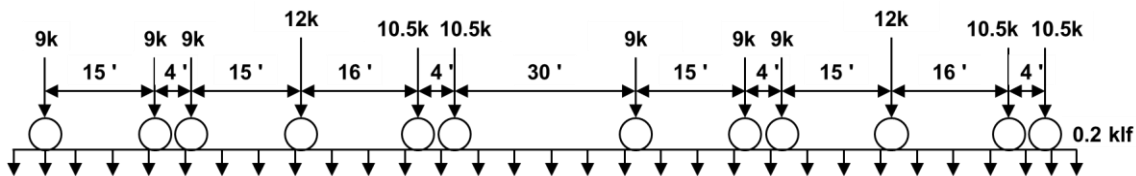
Type 3-3



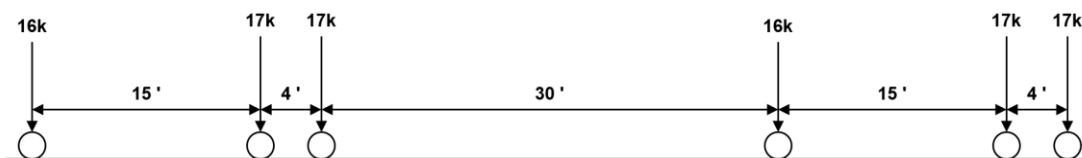
0.75*Type 3-3
+ 0.2 klf lane



2-0.75*Type 3-3
+ 0.2 klf lane

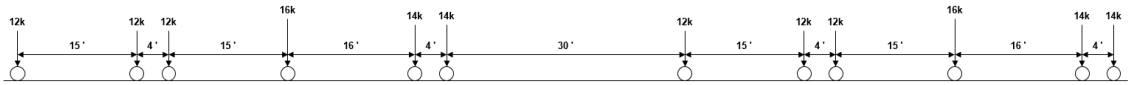


Type 3 Truck
Train





Type 3S2 Truck
Train

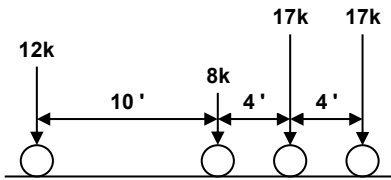


Type 3-3 Truck
Train

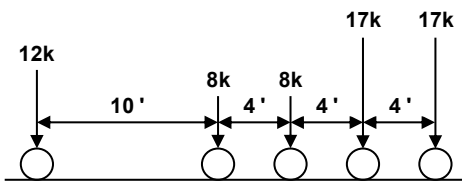
Appendix I: AASHTO MBE Specialized Hauling Vehicles Configurations

Appendix I

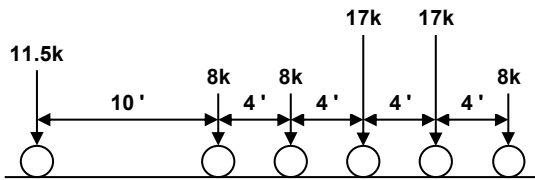
AASHTO Legal Loads (Single Unit Special Hauling Vehicles)



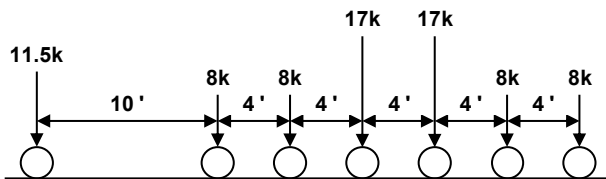
SU4



SU5



SU6



SU7

Appendix J: Controlling Load Cases for AASHTO MBE Legal Rating Trucks

Appendix J

Table- J-1: Controlling Load Effects for AASHTO MBE LRT.

Span [ft]	Controlling Truck								
	M11	S1	M21	M22	S2	M31	M32	M33	S3
10	Type 3	Type 3	Type 3	Type 3S2	Type 3	Type 3	Type 3	Type 3	Type 3
12	Type 3	Type 3	Type 3	Type 3S2	Type 3	Type 3	Type 3S2	Type 3	Type 3
14	Type 3	Type 3	Type 3	Type 3	Type 3	Type 3	Type 3	Type 3	Type 3
16	Type 3	Type 3	Type 3	Type 3	Type 3	Type 3	Type 3	Type 3	Type 3
18	Type 3	Type 3	Type 3	Type 3	Type 3	Type 3	Type 3	Type 3	Type 3
20	Type 3	Type 3	Type 3	Type 3S2	Type 3	Type 3	Type 3	Type 3	Type 3
22	Type 3	Type 3	Type 3	Type 3S2	Type 3	Type 3	Type 3	Type 3	Type 3
24	Type 3	Type 3	Type 3	Type 3S2	Type 3	Type 3	Type 3	Type 3	Type 3
26	Type 3	Type 3	Type 3	Type 3S2	Type 3	Type 3	Type 3S2	Type 3	Type 3
28	Type 3	Type 3	Type 3	Type 3S2	Type 3	Type 3	Type 3S2	Type 3	Type 3
30	Type 3S2	Type 3	Type 3	Type 3S2	Type 3	Type 3	Type 3S2	Type 3	Type 3
50	Type 3	Type 3S2	Type 3	Negative	Type 3S2	Type 3	Type 3S2	Type 3	Type 3S2
75	Type 3S2	Type 3S2	Type 3S2	Negative	Type 3-3	Type 3S2	Negative	Type 3	Type 3S2
100	Type 3-3	Type 3S2	Type 3S2	Negative	Type 3-3	Type 3S2	Negative	Type 3S2	Type 3S2
125	Type 3-3	Type 3-3	Type 3-3	Negative	Type 3-3	Type 3-3	Negative	Type 3S2	Type 3S2
150	Type 3-3	Type 3-3	Type 3-3	Negative	Type 3-3	Type 3-3	Negative	Type 3S2	Type 3-3
175	Type 3-3	Type 3-3	Type 3-3	Negative	Type 3-3	Type 3-3	Negative	Type 3-3	Type 3-3
200	Type 3-3	Long Span	Type 3-3	Negative	Long Span	Type 3-3	Negative	Type 3-3	Long Span
225	Long Span	Long Span	Long Span	Negative	Long Span	Type 3-3	Negative	Long Span	Long Span
250	Long Span	Long Span	Long Span	Negative	Long Span	Type 3-3	Negative	Long Span	Long Span
275	Long Span	Long Span	Long Span	Negative	Long Span	Type 3-3	Negative	Long Span	Long Span
300	Long Span	Long Span	Long Span	Negative	Long Span	Type 3-3	Negative	Long Span	Long Span

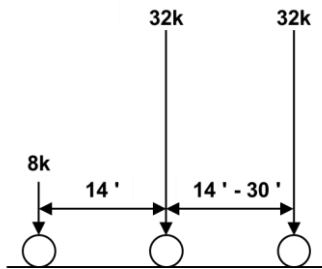
Table- J-2: Controlling Load Effects for AASHTO MBE SHV.

Span [ft]	Controlling Truck								
	M11	S1	M21	M22	S2	M31	M32	M33	S3
10	SU4	SU6	SU4	SU6	SU7	SU4	SU6	SU4	SU5
12	SU4	SU6	SU4	SU7	SU7	SU4	SU6	SU4	SU6
14	SU4	SU7	SU6	SU7	SU7	SU6	SU6	SU5	SU6
16	SU4	SU7	SU6	SU6	SU7	SU6	SU6	SU6	SU6
18	SU6	SU7	SU6	SU7	SU7	SU6	SU6	SU4	SU7
20	SU6	SU7	SU6	SU7	SU7	SU6	SU6	SU4	SU7
22	SU6	SU7	SU7	SU7	SU7	SU7	SU7	SU4	SU7
24	SU6	SU7	SU7	SU7	SU7	SU7	SU7	SU6	SU7
26	SU7	SU7	SU7	SU7	SU7	SU7	SU7	SU6	SU7
28	SU7	SU7	SU7	SU7	SU7	SU7	SU7	SU6	SU7
30	SU7	SU7	SU7	SU7	SU7	SU7	SU7	SU6	SU7
50	SU7	SU7	SU7	SU7	SU7	SU7	SU7	SU7	SU7
75	SU7	SU7	SU7	SU7	SU7	SU7	SU7	SU7	SU7
100	SU7	SU7	SU7	SU7	SU7	SU7	SU7	SU7	SU7
125	SU7	SU7	SU7	SU7	SU7	SU7	SU7	SU7	SU7
150	SU7	SU7	SU7	SU7	SU7	SU7	SU7	SU7	SU7
175	SU7	SU7	SU7	SU7	SU7	SU7	SU7	SU7	SU7
200	SU7	SU7	SU7	SU7	SU7	SU7	SU7	SU7	SU7
225	SU7	SU7	SU7	SU7	SU7	SU7	SU7	SU7	SU7
250	SU7	SU7	SU7	SU7	SU7	SU7	SU7	SU7	SU7
275	SU7	SU7	SU7	SU7	SU7	SU7	SU7	SU7	SU7
300	SU7	SU7	SU7	SU7	SU7	SU7	SU7	SU7	SU7

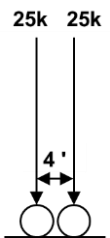
Appendix K: AASHTO HL-93 Design Load Configurations

Appendix K

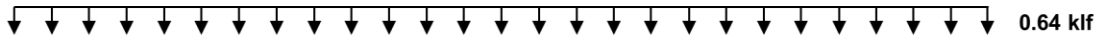
AASHTO HL-93 Design Load



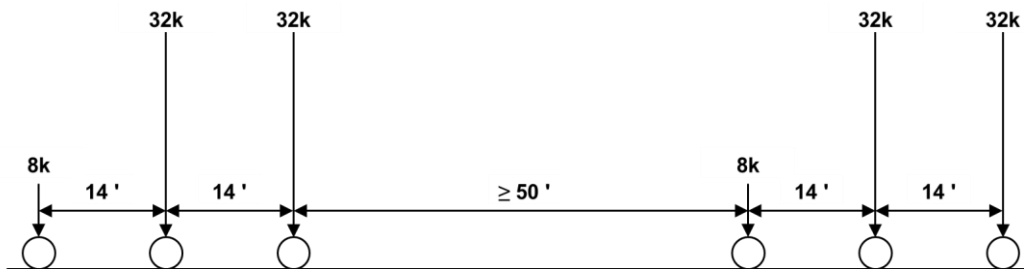
HL-93 Design Truck



HL-93 Design Tandem



HL-93 Design Lane



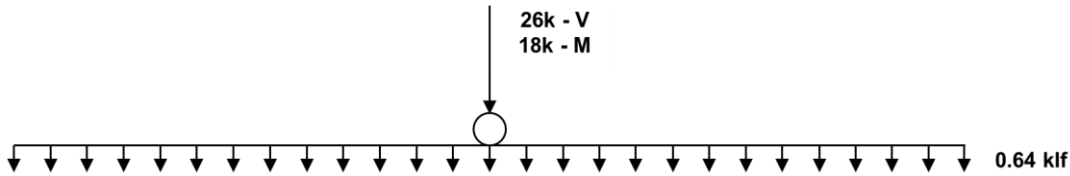
HL-93 Truck
Train
Consider 90% of
truck and lane
load presented on
this figure

Appendix L: AASHTO HS-20 Design Load Configurations

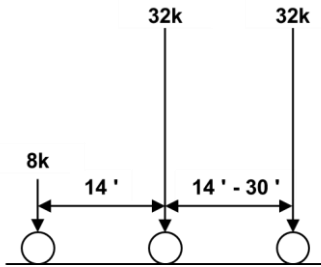
Appendix L

AASHTO HS-20 Design Load

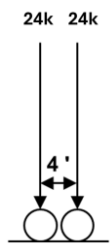
HS-20 Point Lane



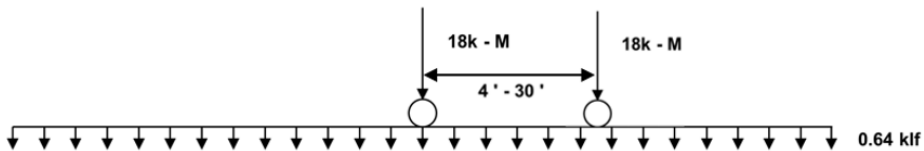
HS-20 Design Truck



HS-20 Military Load



HS 20 Lane for
Negative Moment



Appendix M: Controlling Load Effects for AASHTO Design Trucks

Appendix M

Table M-1: Controlling Load Effects for AASHTO HS-20.

Span [ft]	Controlling Truck								
	M11	S1	M21	M22	S2	M31	M32	M33	S3
10	Truck	Truck	Truck	Truck	Truck	Truck	Negative	Truck	Tandem
12	Truck	Truck	Tandem	Truck	Truck	Truck	Truck	Truck	Tandem
14	Tandem	Truck	Tandem	Truck	Truck	Tandem	Truck	Truck	Tandem
16	Tandem	Truck	Tandem	Truck	Truck	Tandem	Truck	Truck	Tandem
18	Tandem	Truck	Tandem	Truck	Truck	Tandem	Truck	Truck	Tandem
20	Tandem	Truck	Tandem	Truck	Truck	Tandem	Truck	Tandem	Tandem
22	Tandem	Truck	Tandem	Truck	Truck	Tandem	Truck	Tandem	Tandem
24	Tandem	Truck	Tandem	Truck	Truck	Tandem	Truck	Tandem	Tandem
26	Tandem	Truck	Tandem	Truck	Truck	Tandem	Truck	Tandem	Tandem
28	Tandem	Truck	Tandem	Truck	Truck	Tandem	Truck	Tandem	Tandem
30	Tandem	Truck	Tandem	Truck	Truck	Tandem	Truck	Tandem	Tandem
50	Truck	Truck	Truck	Negative	Truck	Truck	Negative	Tandem	Truck
75	Truck	Truck	Truck	Negative	Truck	Truck	Negative	Truck	Truck
100	Truck	Point Lane	Truck	Negative	Truck	Truck	Negative	Truck	Point Lane
125	Truck	Point Lane	Truck	Negative	Point Lane	Truck	Negative	Truck	Point Lane
150	Point Lane	Point Lane	Truck	Negative	Point Lane	Truck	Negative	Truck	Point Lane
175	Point Lane	Point Lane	Point Lane	Negative	Point Lane	Truck	Negative	Point Lane	Point Lane
200	Point Lane	Point Lane	Point Lane	Negative	Point Lane	Truck	Negative	Point Lane	Point Lane
225	Point Lane	Point Lane	Point Lane	Negative	Point Lane	Point Lane	Negative	Point Lane	Point Lane
250	Point Lane	Point Lane	Point Lane	Negative	Point Lane	Point Lane	Negative	Point Lane	Point Lane
275	Point Lane	Point Lane	Point Lane	Negative	Point Lane	Point Lane	Negative	Point Lane	Point Lane
300	Point Lane	Point Lane	Point Lane	Negative	Point Lane	Point Lane	Negative	Point Lane	Point Lane

Table M-2: Controlling Load Effects for AASHTO HL-93.

Span [ft]	Controlling HL-93 Load Case								
	M11	S1	M21	M22	S2	M31	M32	M33	S3
10	Truck	Truck	Truck	Truck	Truck	Truck	Tandem	Truck	Tandem
12	Tandem	Truck	Tandem	Truck	Truck	Tandem	Truck	Truck	Tandem
14	Tandem	Truck	Tandem	Truck	Truck	Tandem	Truck	Truck	Tandem
16	Tandem	Truck	Tandem	Truck	Truck	Tandem	Truck	Truck	Tandem
18	Tandem	Truck	Tandem	Truck	Truck	Tandem	Truck	Tandem	Tandem
20	Tandem	Truck	Tandem	Truck	Truck	Tandem	Truck	Tandem	Tandem
22	Tandem	Truck	Tandem	Truck	Truck	Tandem	Truck	Tandem	Tandem
24	Tandem	Truck	Tandem	Truck	Truck	Tandem	Truck	Tandem	Tandem
26	Tandem	Truck	Tandem	Truck	Truck	Tandem	Truck	Tandem	Tandem
28	Tandem	Truck	Tandem	Truck	Truck	Tandem	Truck	Tandem	Tandem
30	Tandem	Truck	Tandem	Truck	Truck	Tandem	Truck	Tandem	Tandem
50	Truck	Truck	Truck	Negative	Truck	Truck	Truck	Tandem	Truck
75	Truck	Truck	Truck	Negative	Truck	Truck	Negative	Truck	Truck
100	Truck	Truck	Truck	Negative	Truck	Truck	Negative	Truck	Truck
125	Truck	Truck	Truck	Negative	Truck	Truck	Negative	Truck	Truck
150	Truck	Truck	Truck	Negative	Truck	Truck	Negative	Truck	Truck
175	Truck	Truck	Truck	Negative	Truck	Truck	Negative	Truck	Truck
200	Truck	Truck	Truck	Negative	Truck	Truck	Negative	Truck	Truck
225	Truck	Truck	Truck	Negative	Truck	Truck	Negative	Truck	Truck
250	Truck	Truck	Truck	Negative	Truck	Truck	Negative	Truck	Truck
275	Truck	Truck	Truck	Negative	Truck	Truck	Negative	Truck	Truck
300	Truck	Truck	Truck	Negative	Truck	Truck	Negative	Truck	Truck

Appendix N: Characteristics of Alaska Trucks with more than 7 axles

Appendix N

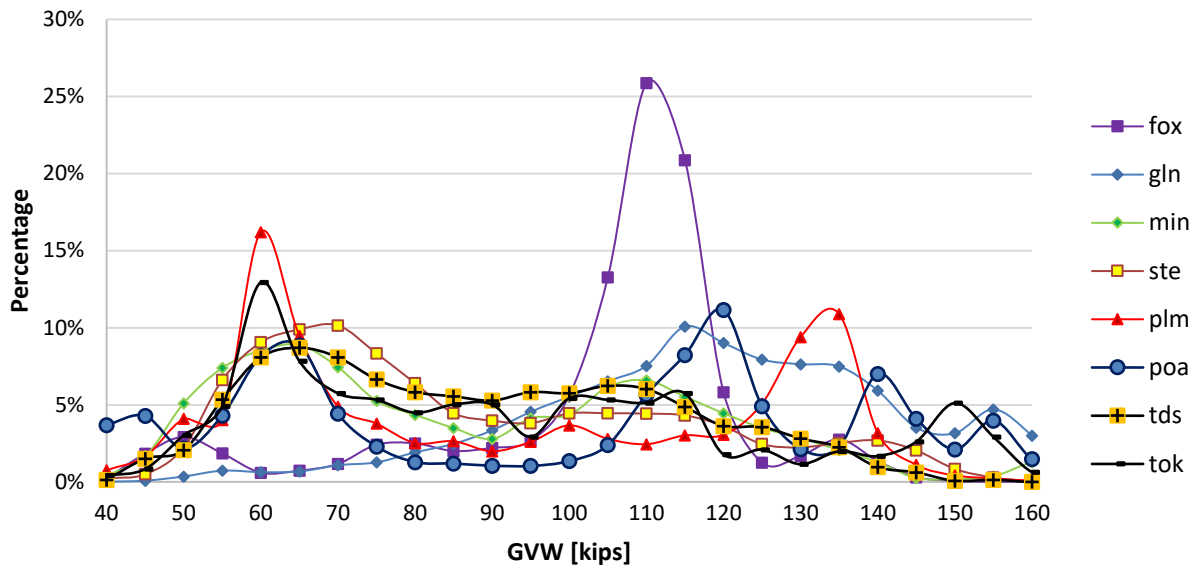


Figure- N-1: Alaska Trucks, GVW distribution

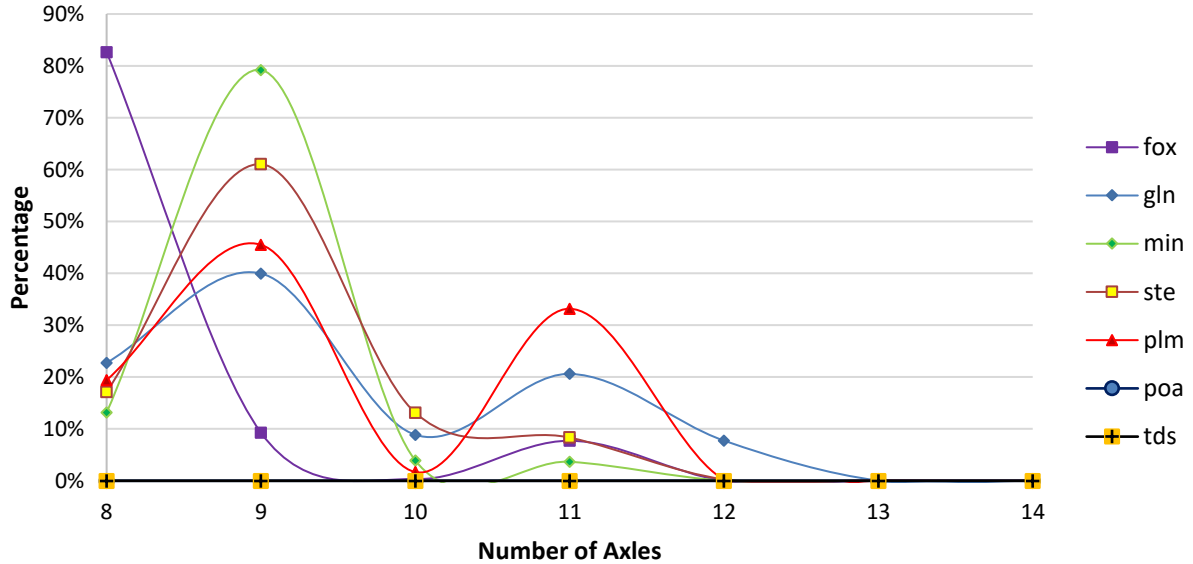


Figure- N-2: Alaska Trucks, number of axle distribution.

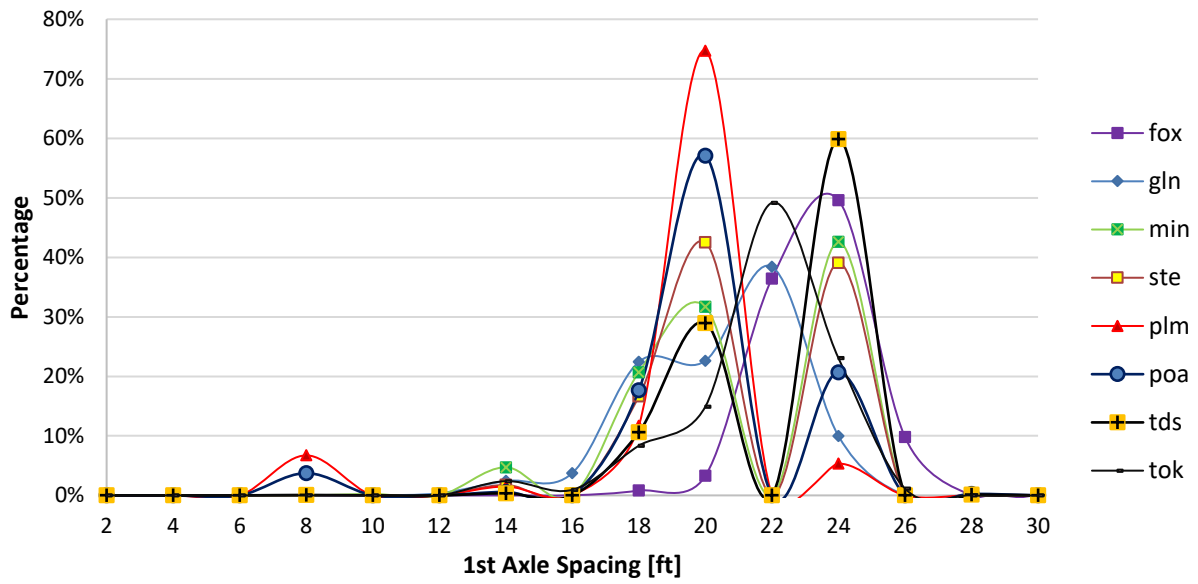


Figure- N-3: Alaska Trucks, 1st axle spacing distribution

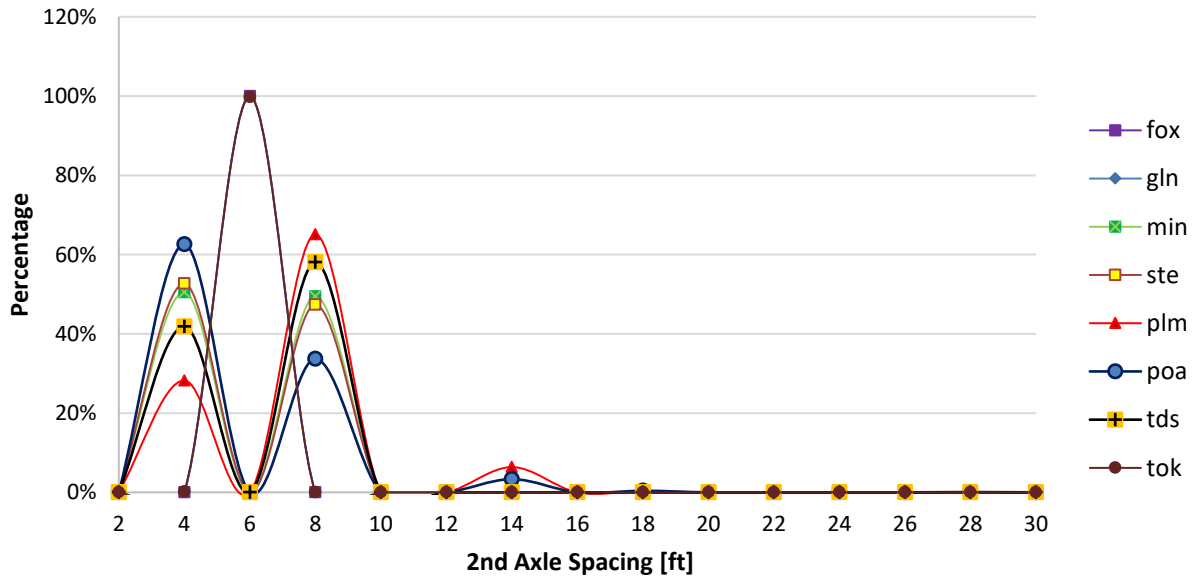


Figure- N-4: Alaska Trucks, 2nd axle spacing distribution

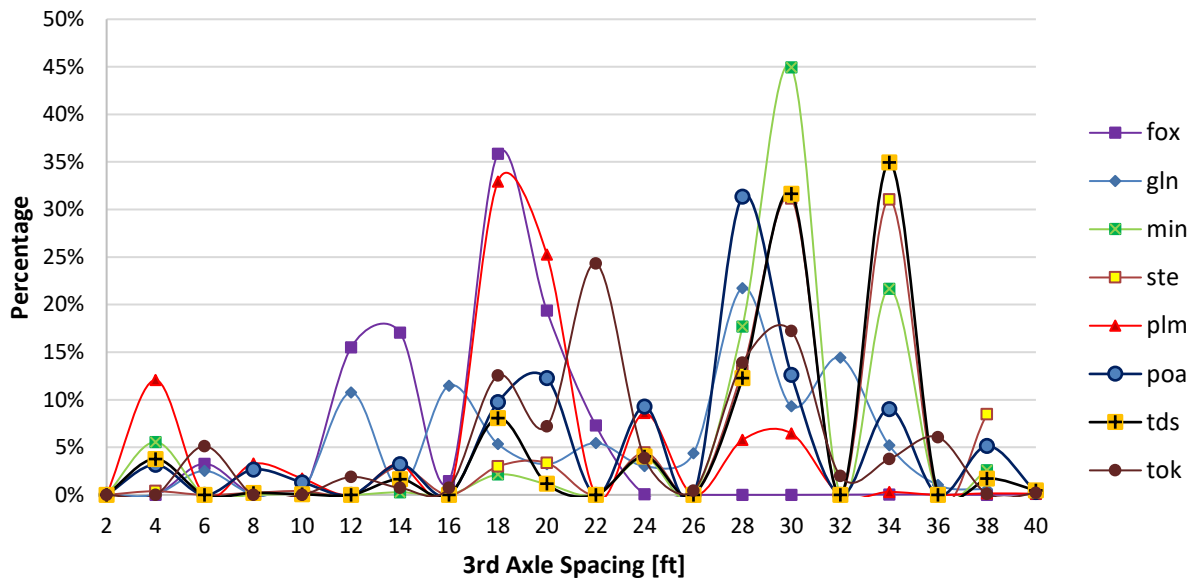


Figure- N-5: Alaska Trucks, 3rd axle spacing distribution

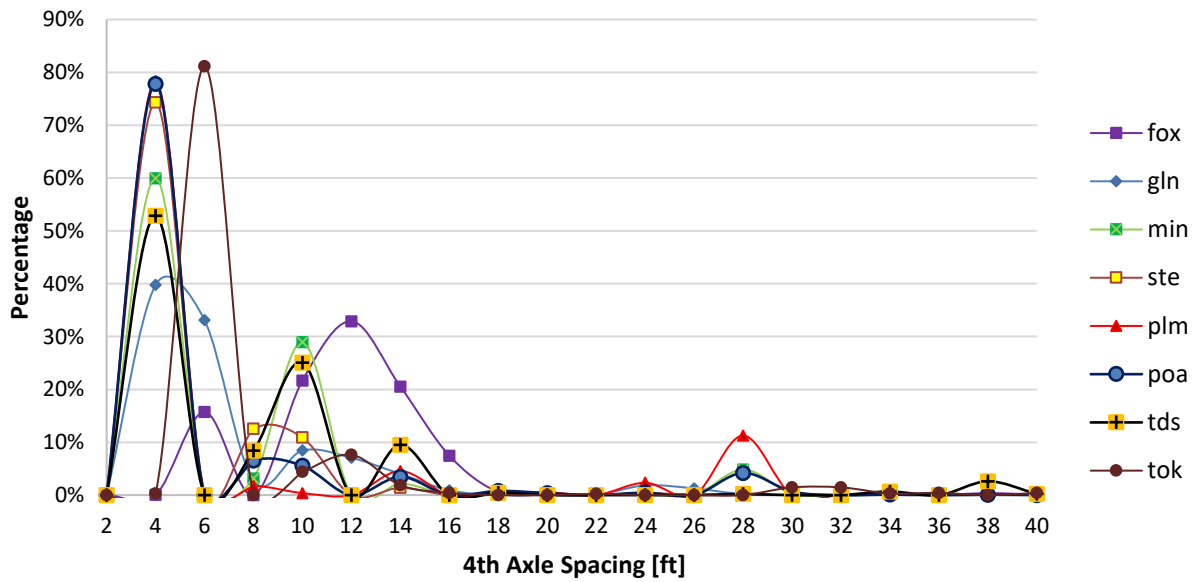


Figure- N-6: Alaska Trucks, 4th axle spacing distribution

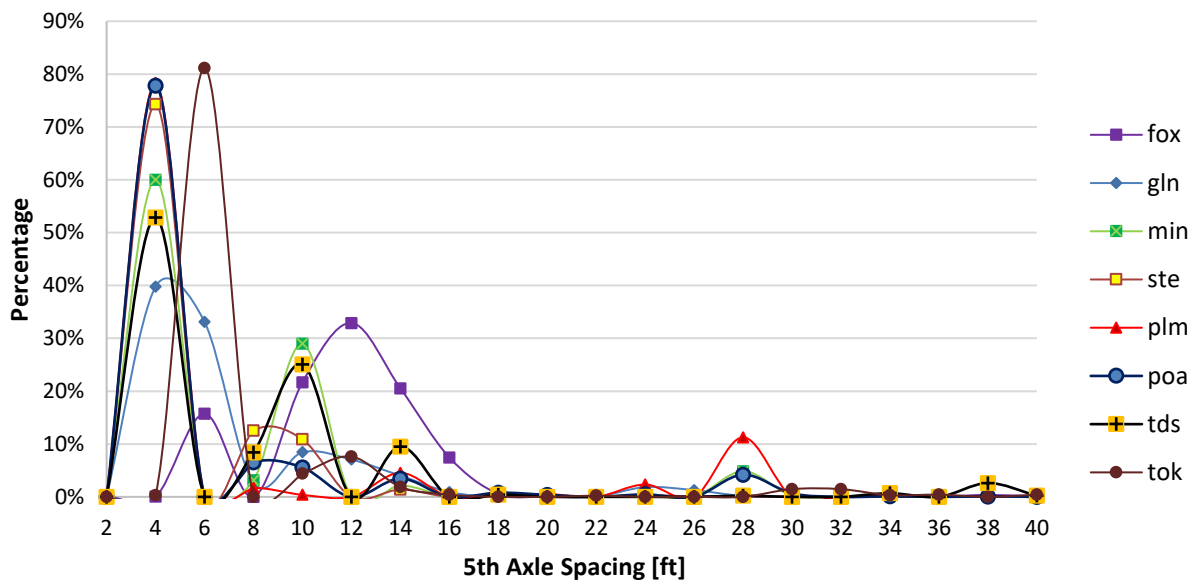


Figure- N-7: Alaska Trucks, 5th axle spacing distribution

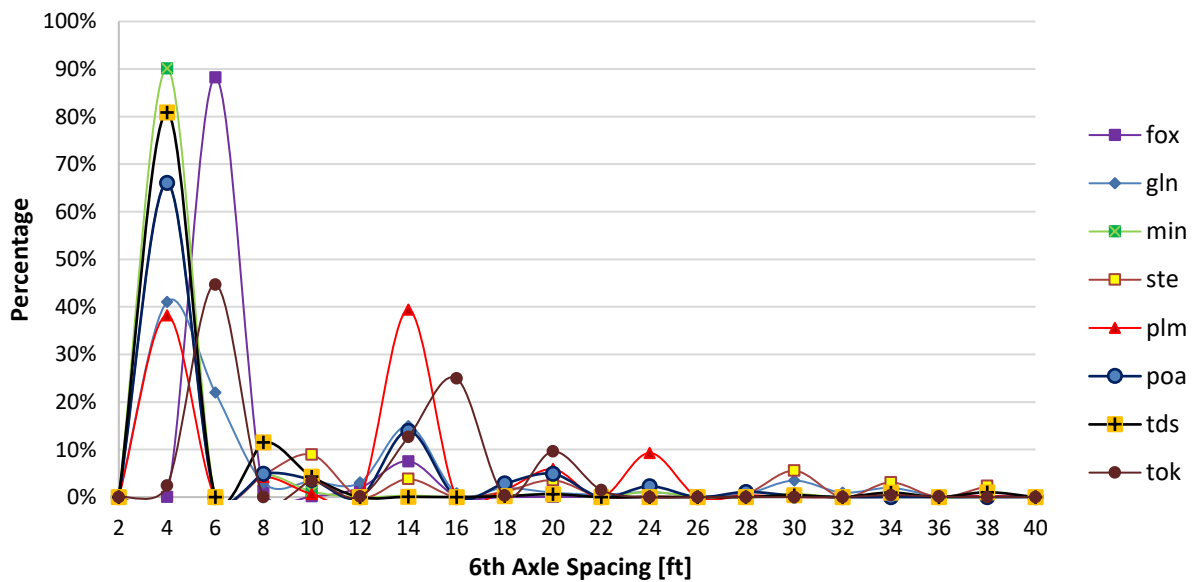


Figure- N-8: Alaska Trucks, 6th axle spacing distribution

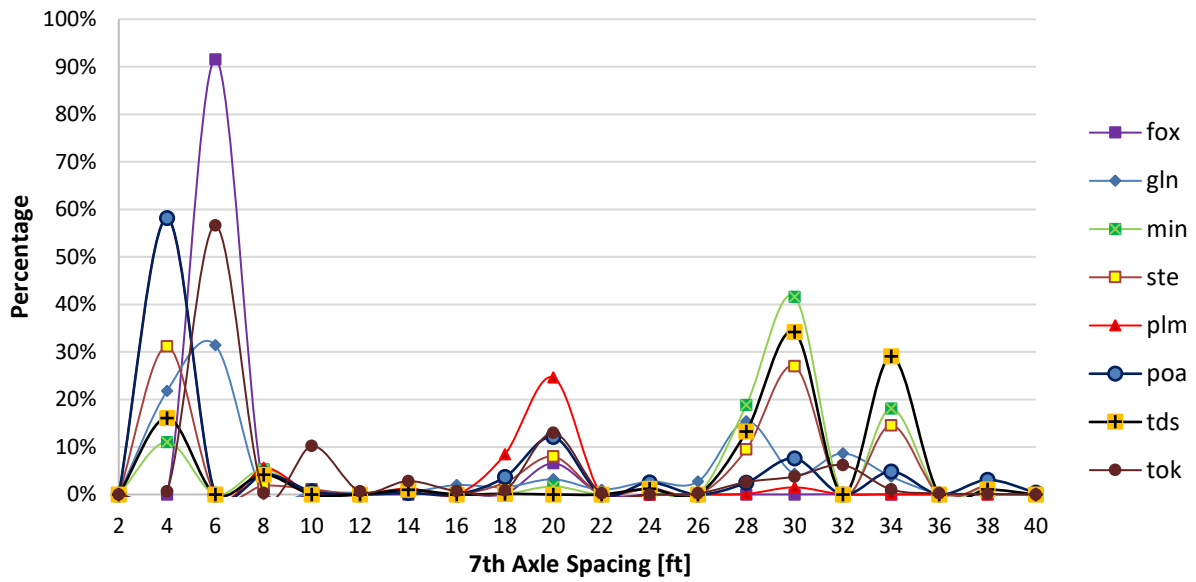


Figure- N-9: Alaska Trucks, 7th axle spacing distribution

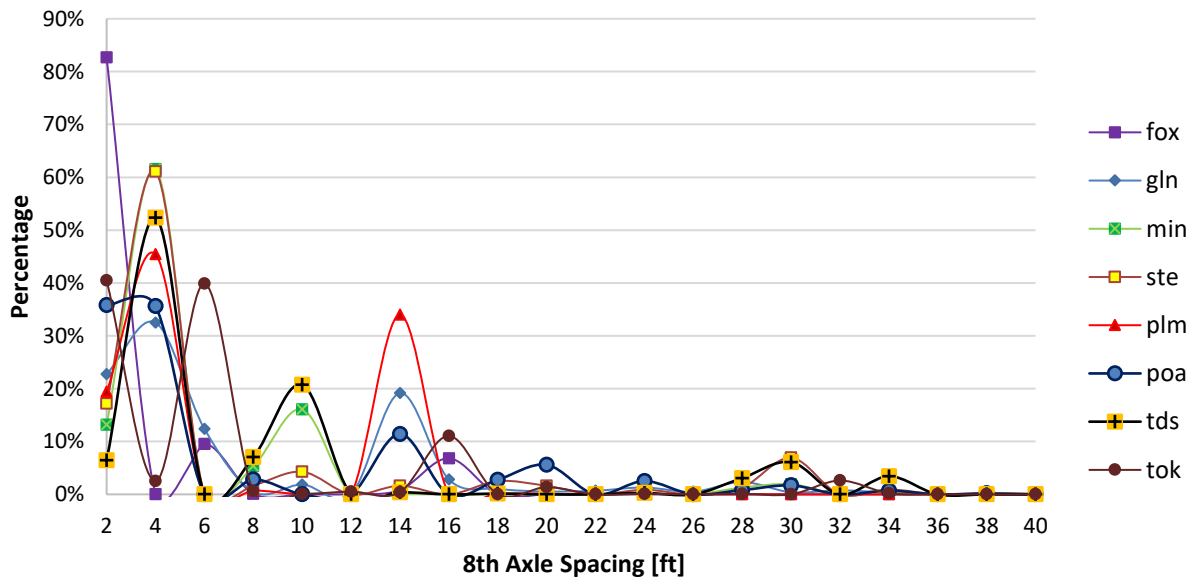


Figure- N-10: Alaska Trucks, 8th axle spacing distribution

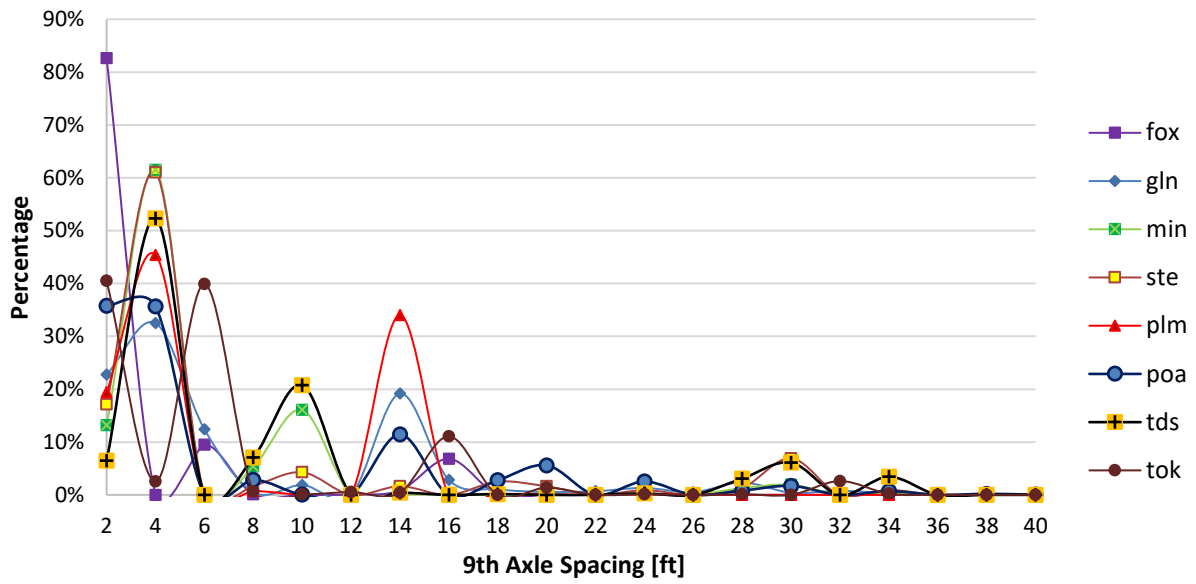


Figure- N-11: Alaska Trucks, 9th axle spacing distribution

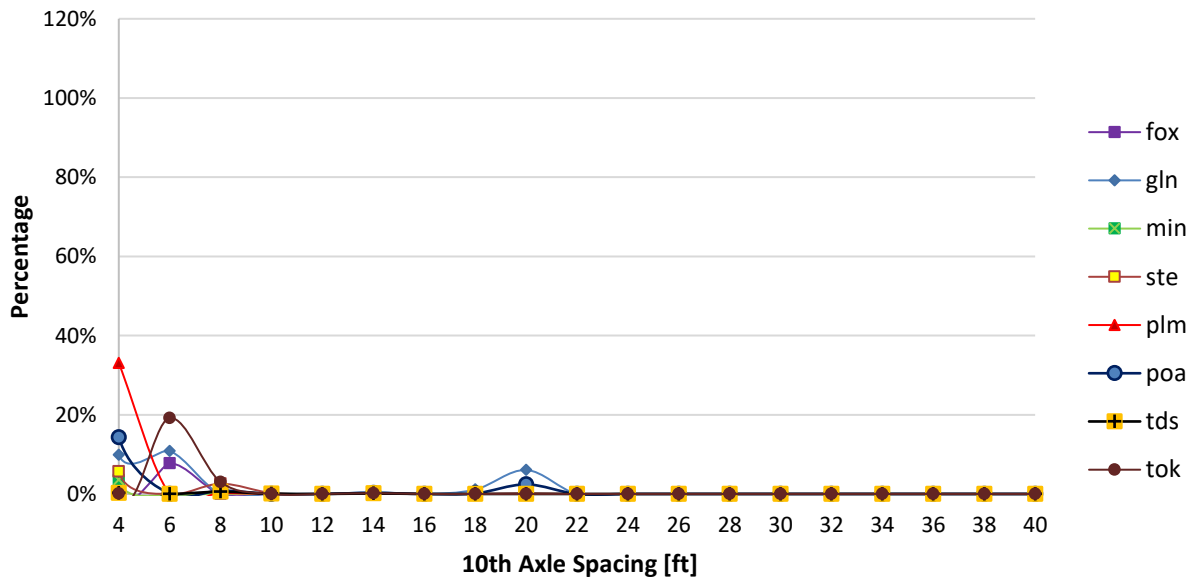


Figure- N-12: Alaska Trucks, 10th axle spacing distribution

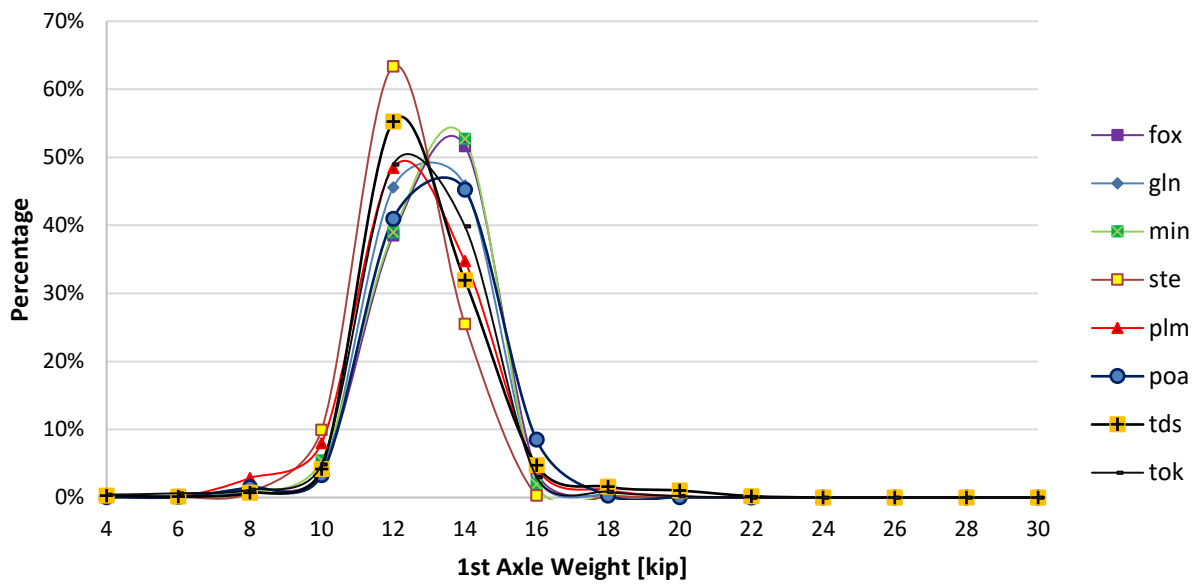


Figure- N-13: Alaska Trucks, 1st axle weight distribution

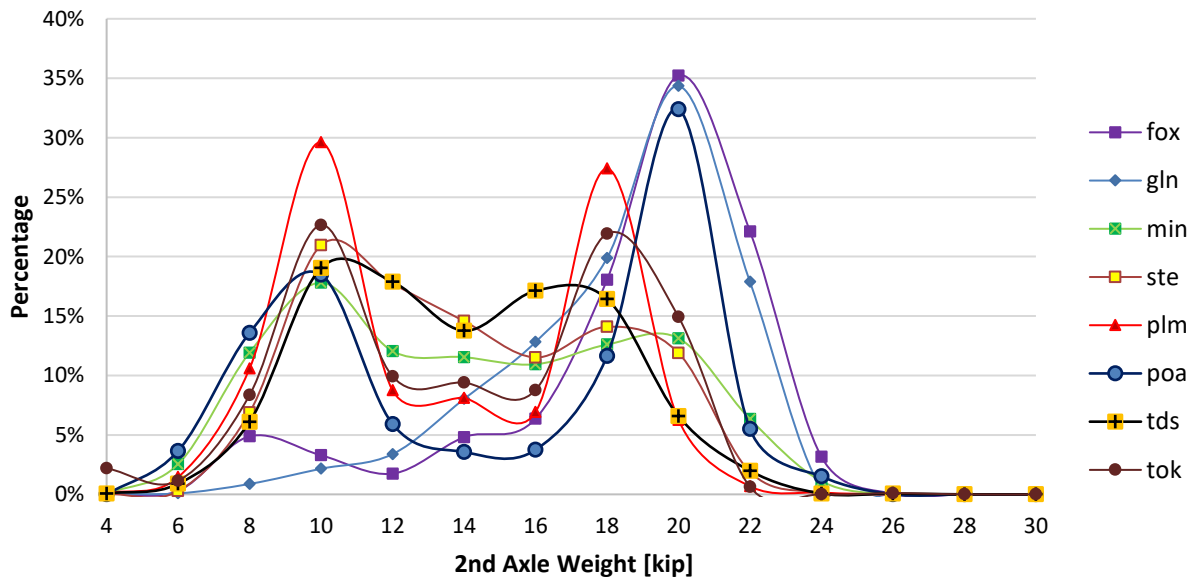


Figure- N-14: Alaska Trucks, 2nd axle weight distribution

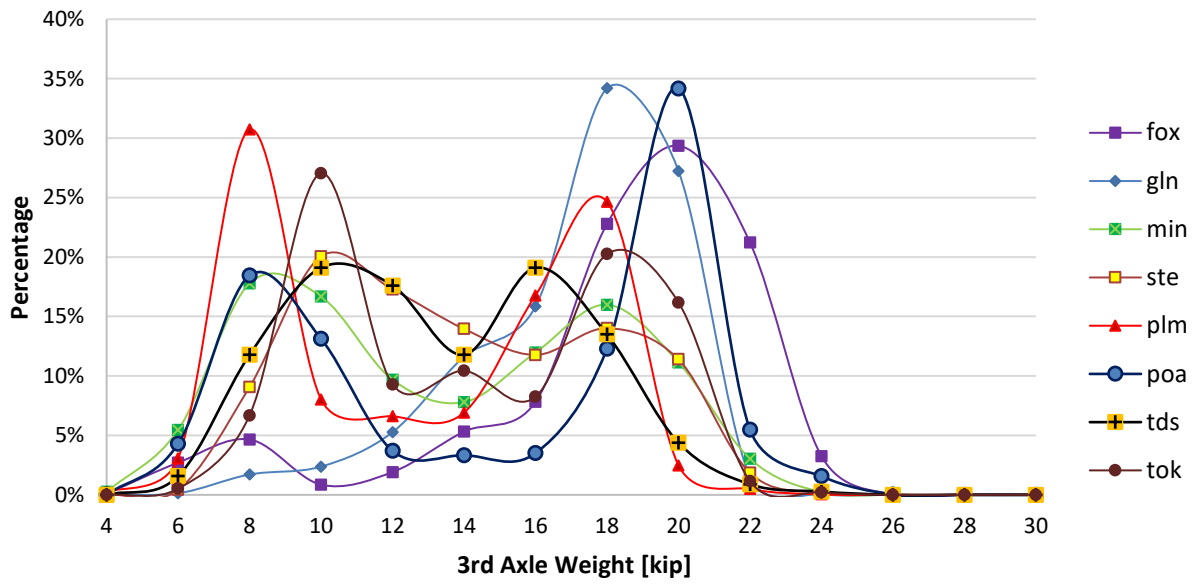


Figure- N-15: Alaska Trucks, 3rd axle weight distribution

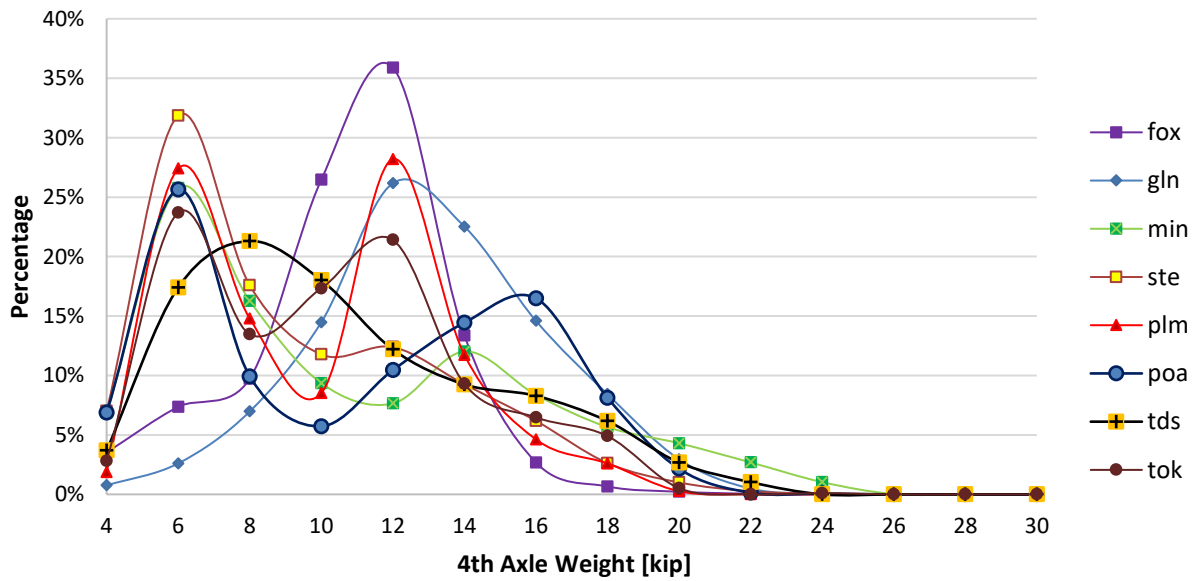


Figure- N-16: Alaska Trucks, 4th axle weight distribution

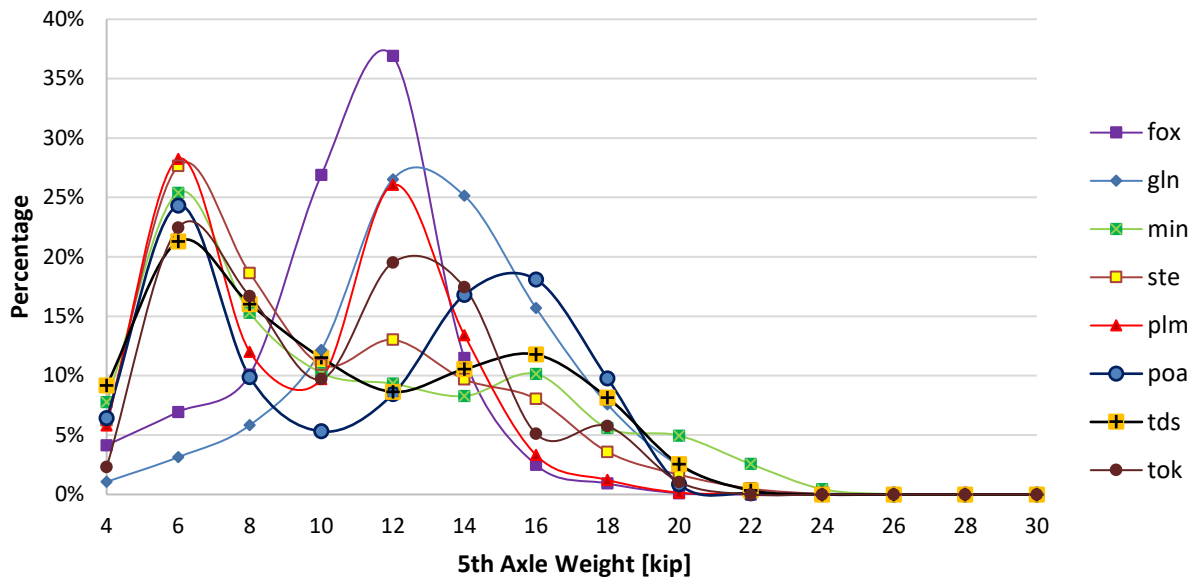


Figure- N-17: Alaska Trucks, 5th axle weight distribution

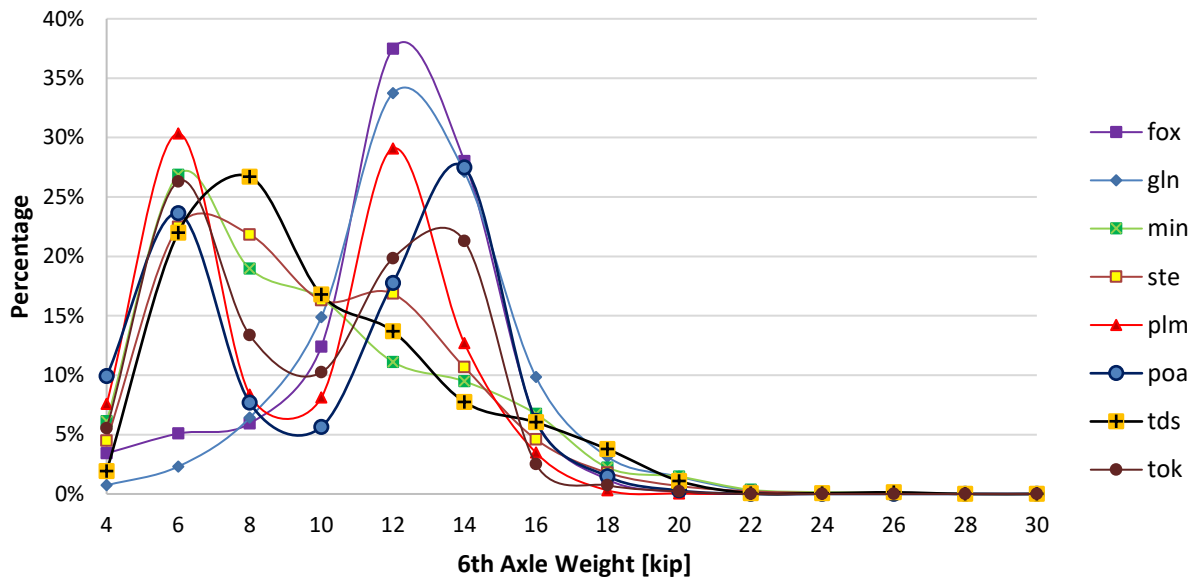


Figure- N-18: Alaska Trucks, 6th axle weight distribution

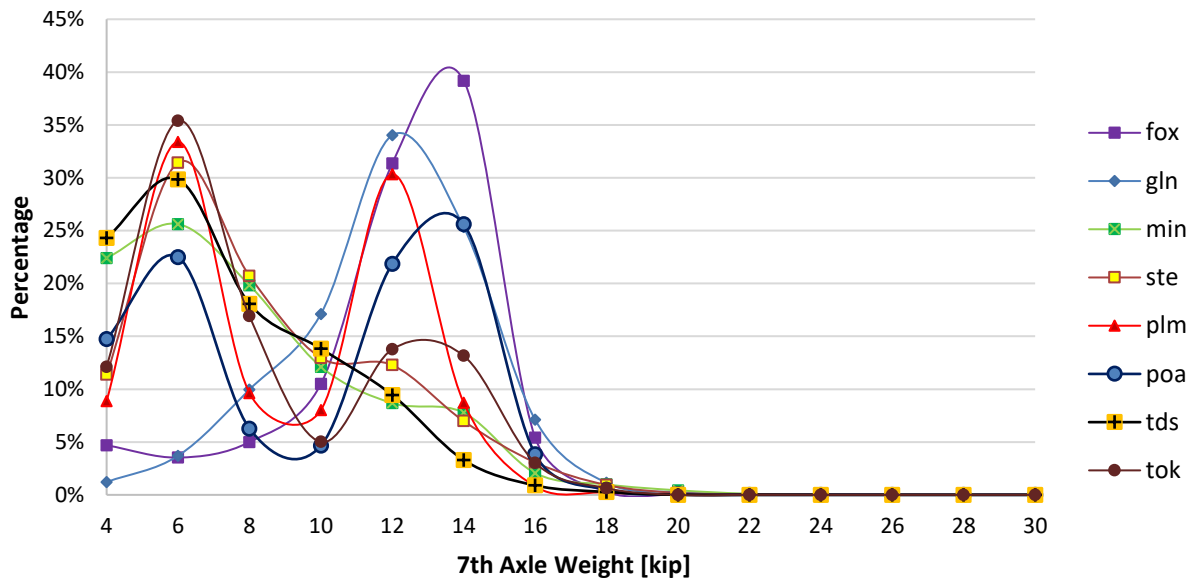


Figure- N-19: Alaska Trucks, 7th axle weight distribution

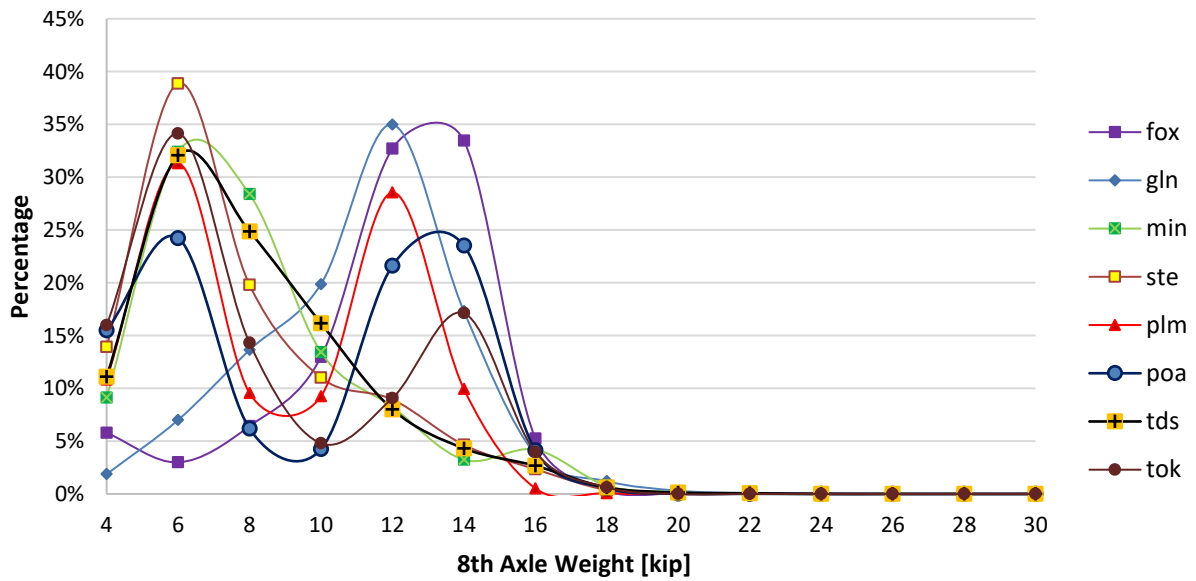


Figure- N-20: Alaska Trucks, 8th axle weight distribution

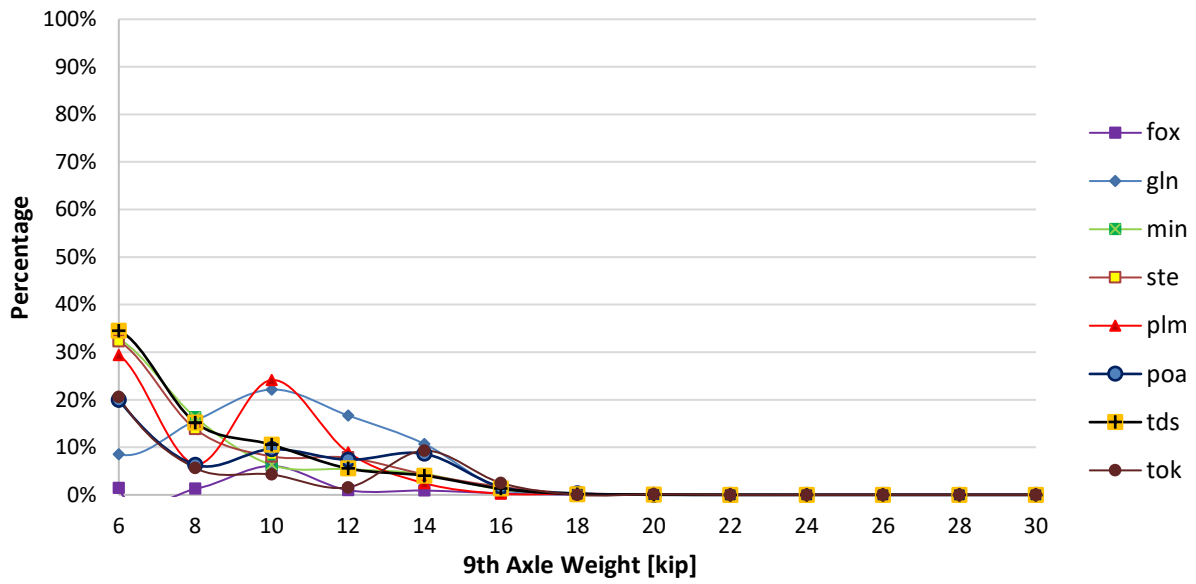


Figure- N-21: Alaska Trucks, 9th axle weight distribution

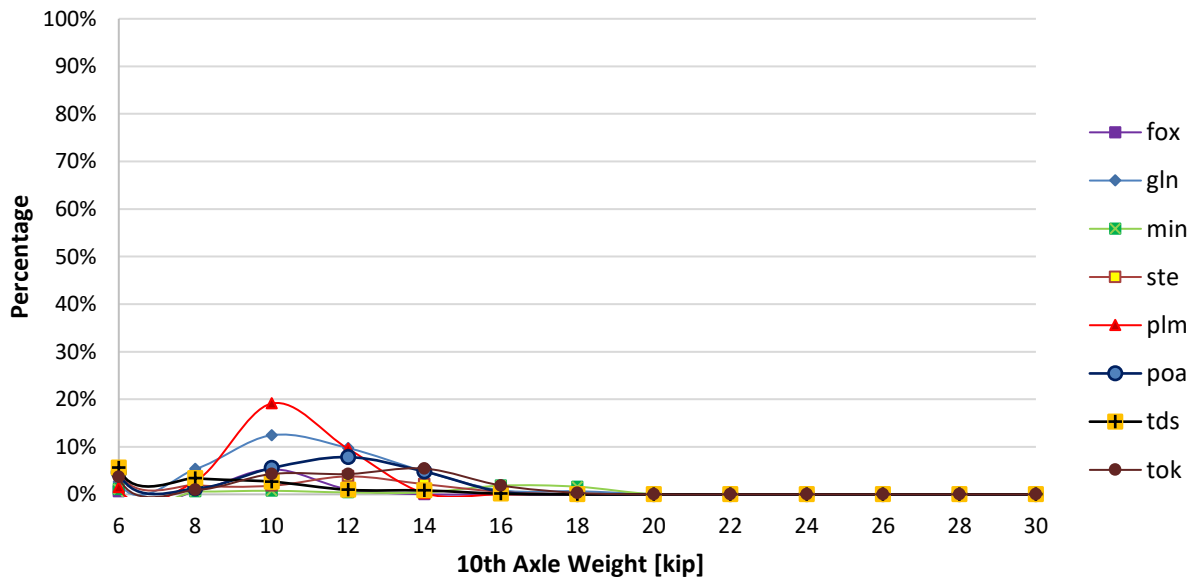


Figure- N-22: Alaska Trucks, 10th axle weight distribution

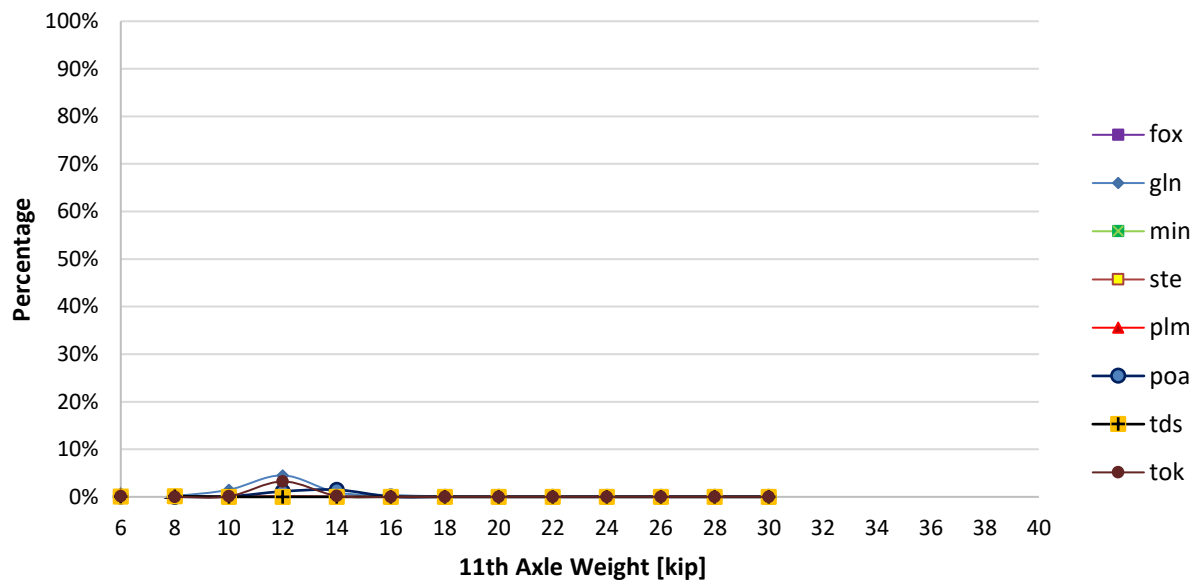
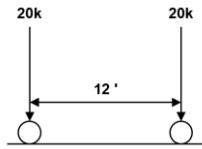


Figure- N-23: Alaska Trucks, 11th axle weight distribution

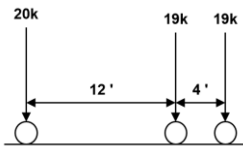
Appendix O: Alaska Typical Truck Configurations

Appendix O

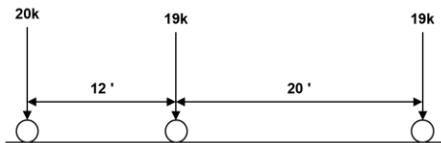
Alaska Typical Legal Trucks



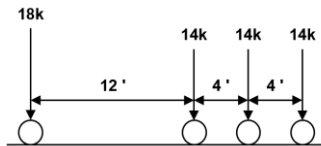
Candidate #1



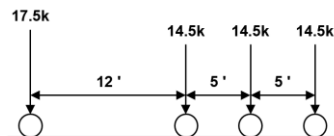
Candidate #2



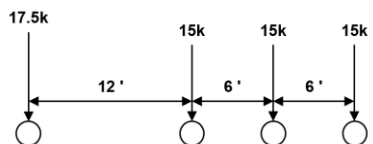
Candidate #3



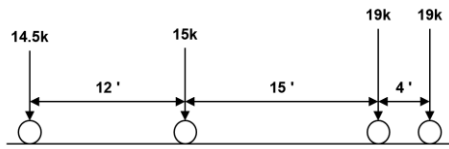
Candidate #4



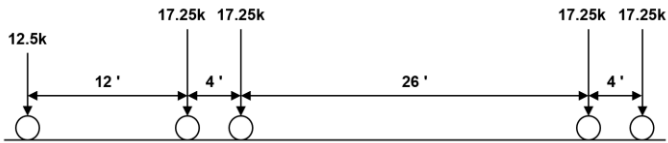
Candidate #5



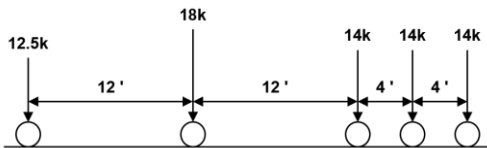
Candidate #6



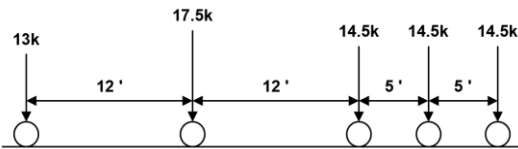
Candidate #7



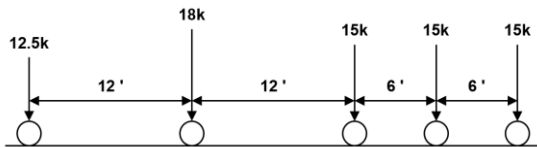
Candidate #8



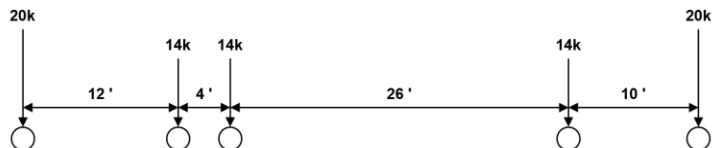
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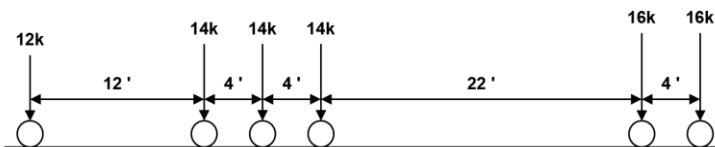
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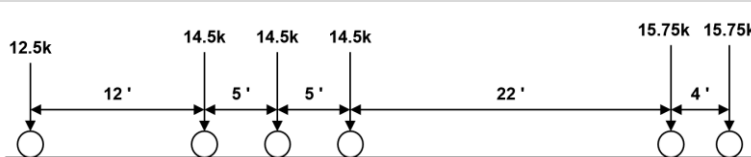
Candidate #11



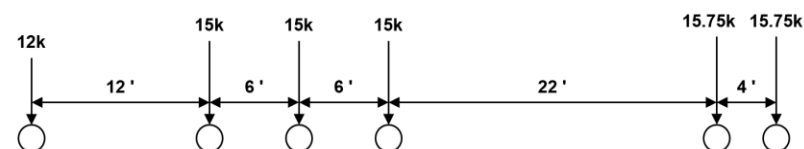
Candidate #12



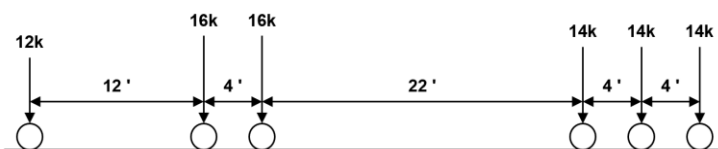
Candidate #13



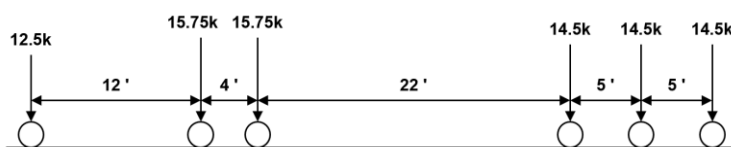
Candidate #14



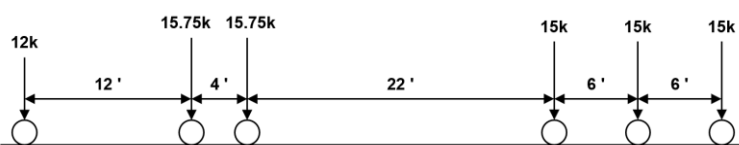
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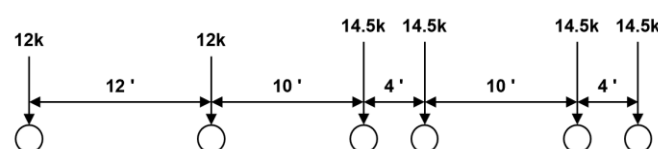
Candidate #16



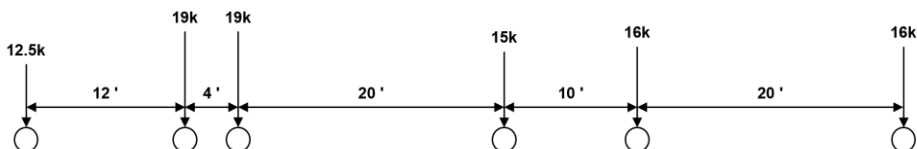
Candidate #17



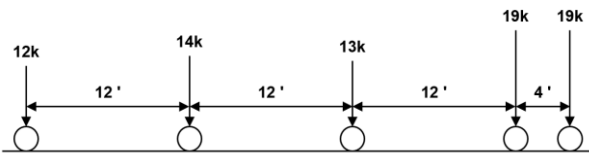
Candidate #18



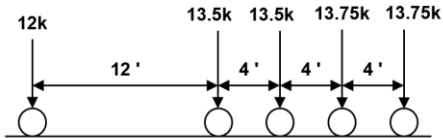
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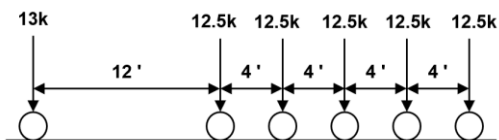
Candidate #20



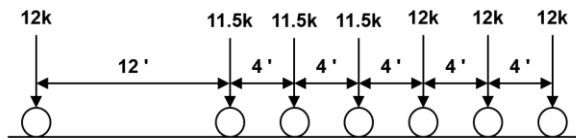
Candidate #21



Candidate #22

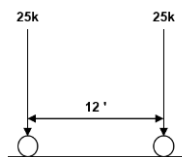


Candidate #23

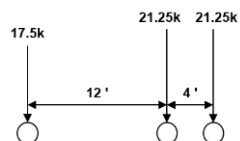


Candidate #24

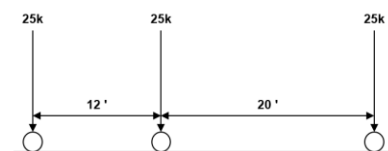
Alaska Typical Routine Permit Trucks



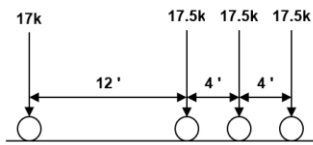
Routine Permit Candidate #1



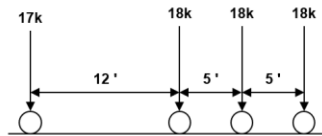
Routine Permit Candidate #2



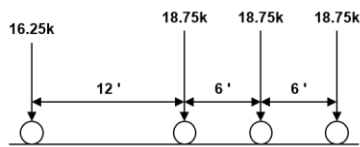
Routine Permit Candidate #3



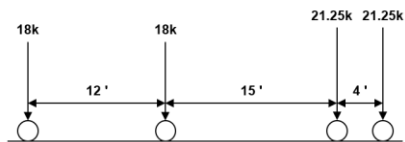
Routine Permit Candidate #4



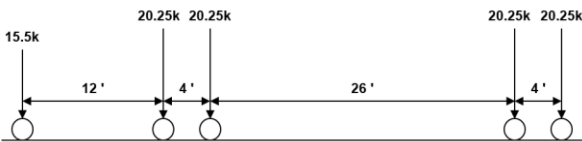
Routine Permit Candidate #5



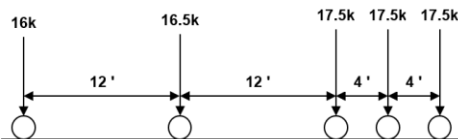
Routine Permit Candidate #6



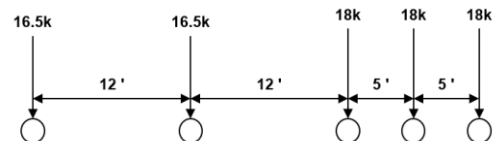
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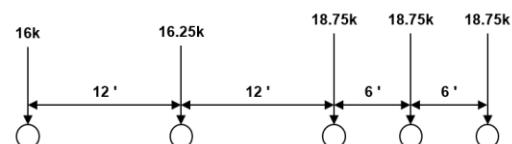
Routine Permit Candidate #8



Routine Permit Candidate #9



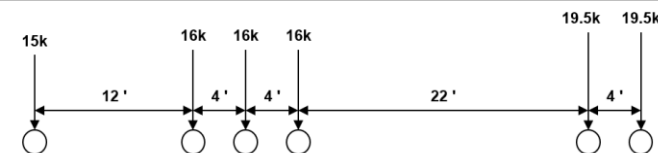
Routine Permit Candidate #10



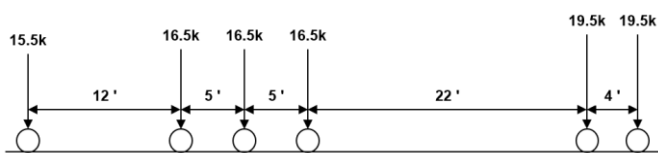
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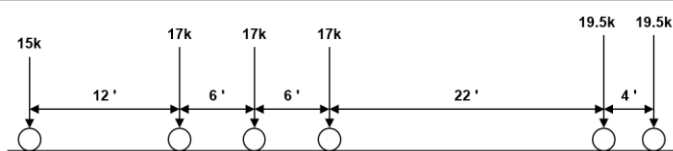
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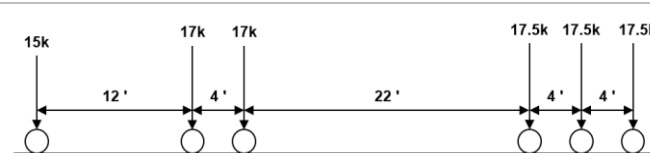
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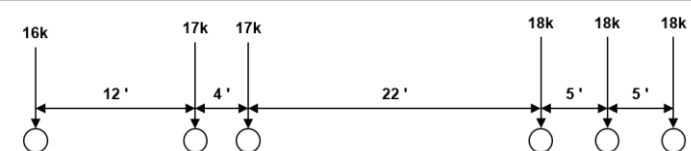
Routine Permit Candidate #14



Routine Permit Candidate #15



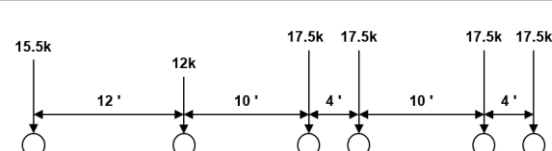
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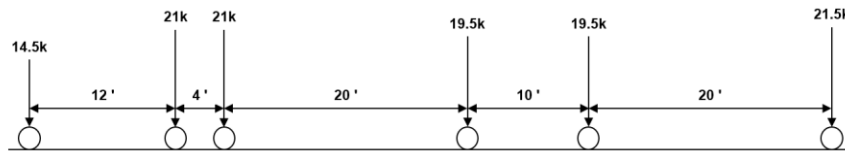
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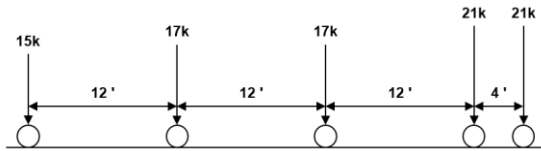
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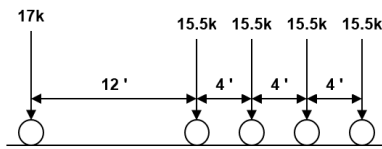
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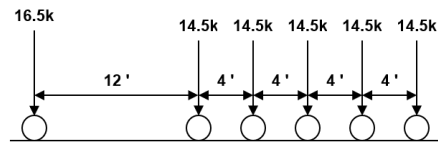
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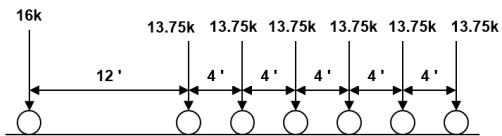
Routine Permit Candidate #21



Routine Permit Candidate #22



Routine Permit Candidate #23

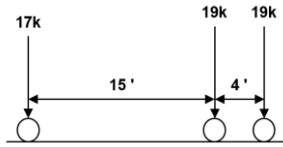


Routine Permit Candidate #24

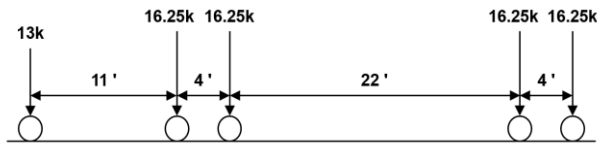
Appendix P: Alaska AASHTO MBE Legal Configurations

Appendix P

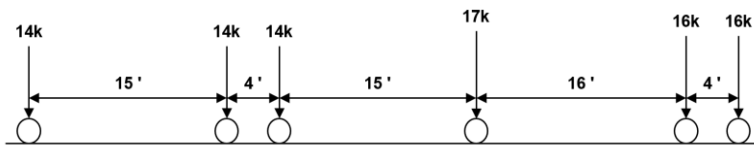
Alaska Legal AASHTO MBE Trucks



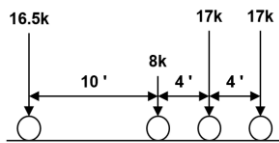
Candidate #25



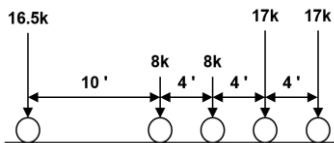
Candidate #26



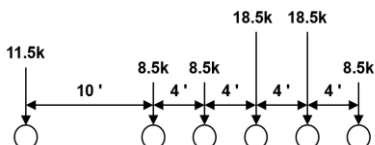
Candidate #27



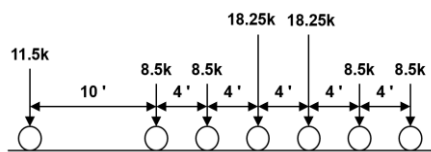
Candidate #28



Candidate #29

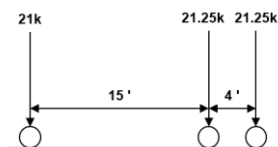


Candidate #30

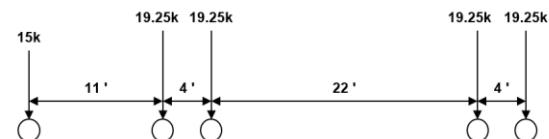


Candidate #31

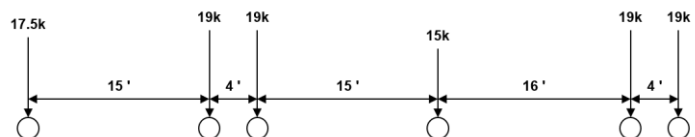
Alaska Routine Permit AASHTO MBE Trucks



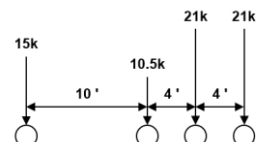
Routine Permit Candidate #25



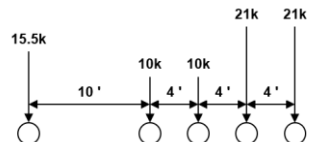
Routine Permit Candidate #26



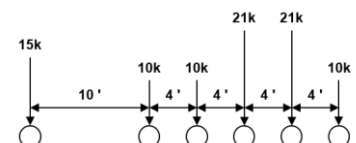
Routine Permit Candidate #27



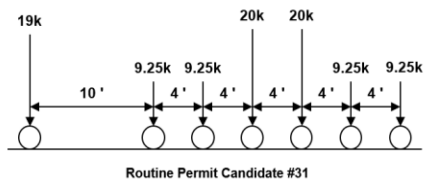
Routine Permit Candidate #28



Routine Permit Candidate #29



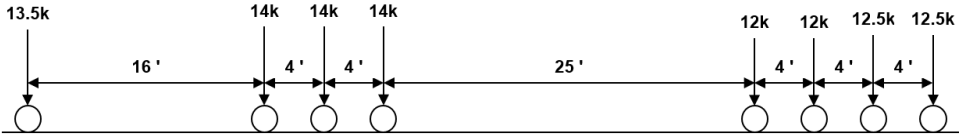
Routine Permit Candidate #30



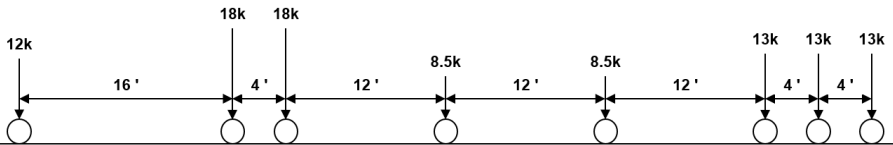
Appendix Q: Alaska Combination and Long Combination Vehicle Configurations

Appendix Q

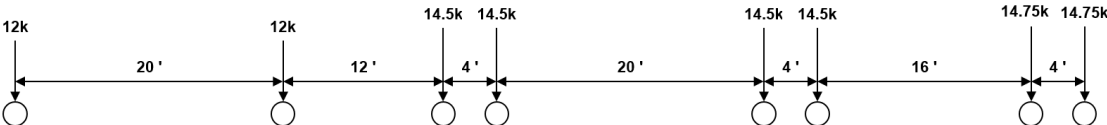
Alaska Legal Combination and Long Combination Vehicles



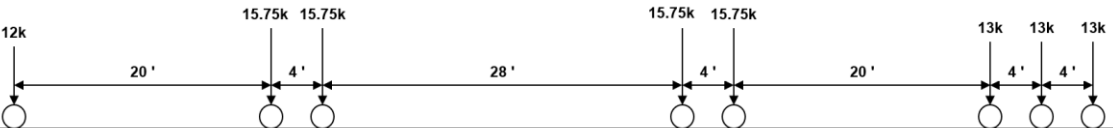
Candidate #32



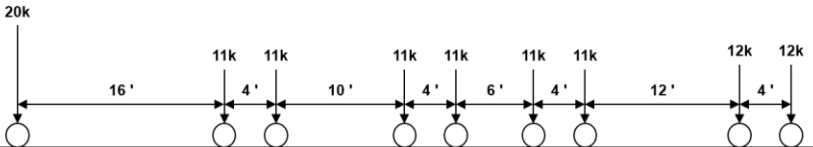
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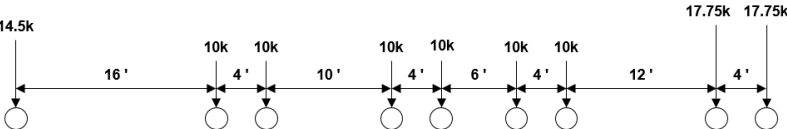
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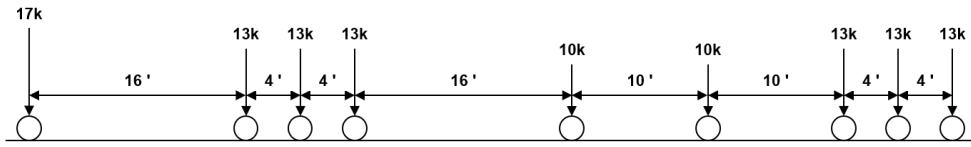
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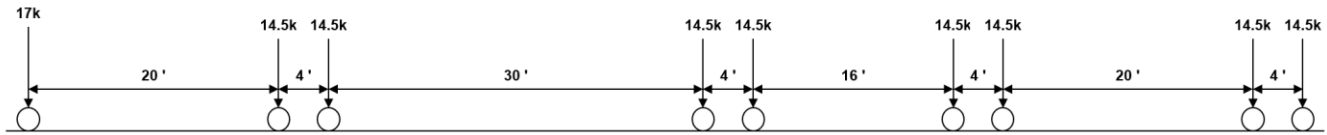
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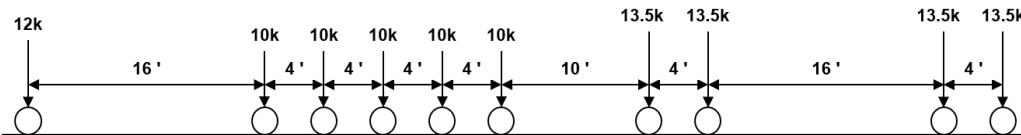
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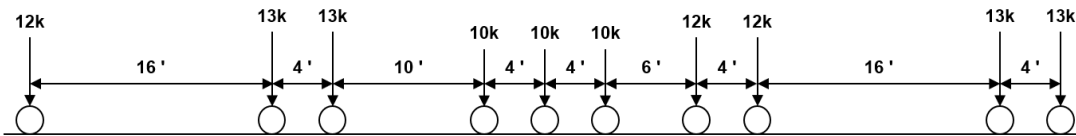
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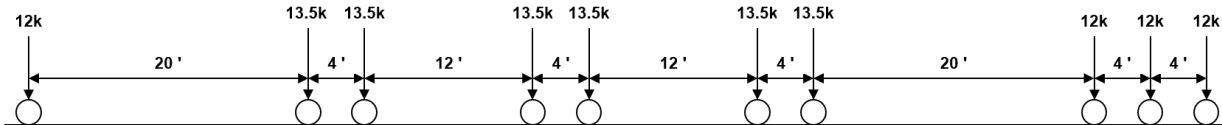
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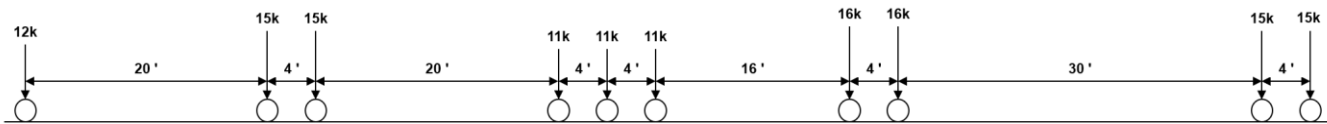
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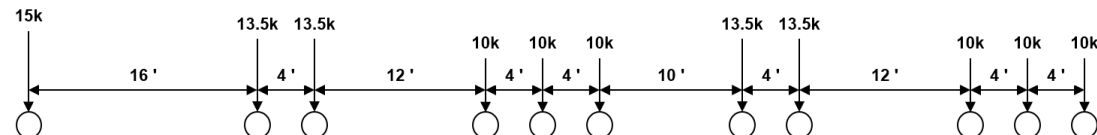
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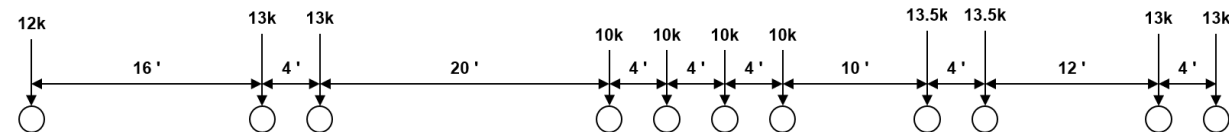
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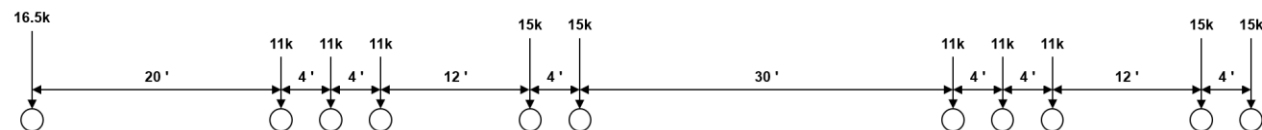
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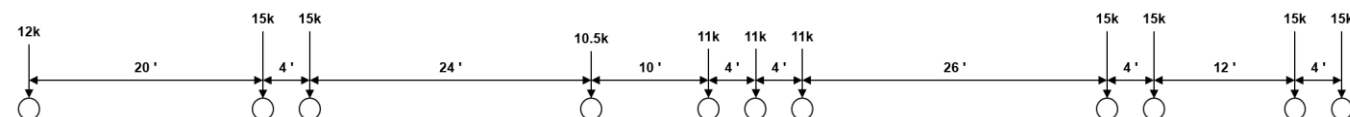
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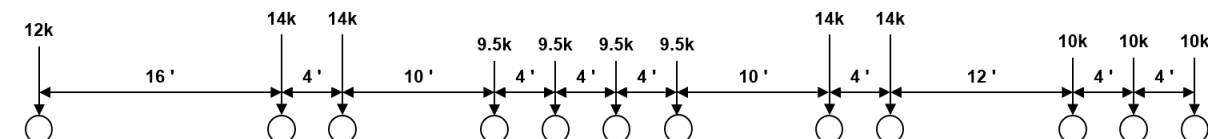
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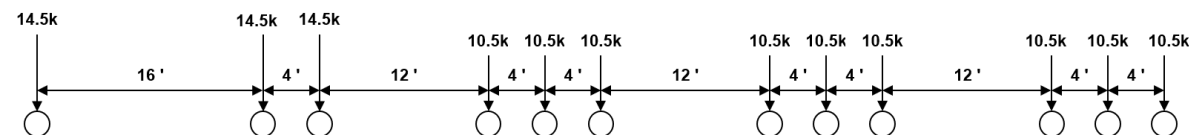
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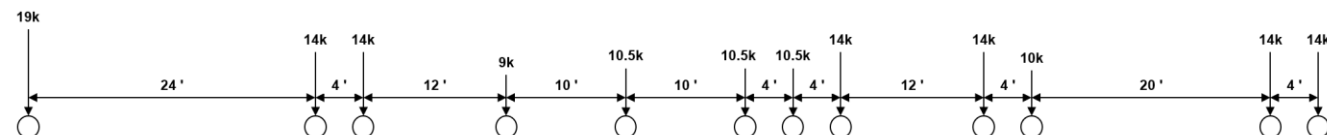
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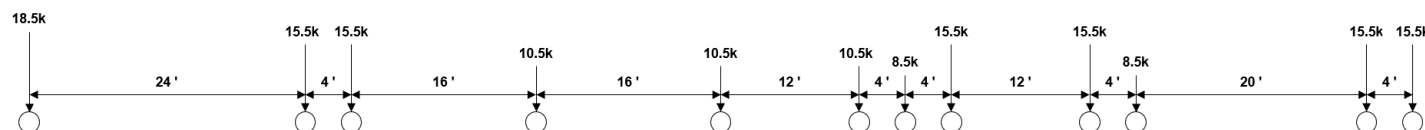
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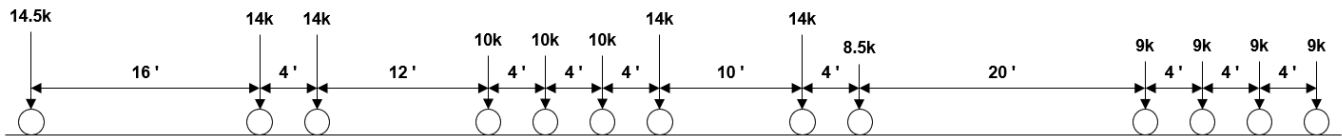
Candidate #49



Candidate #50



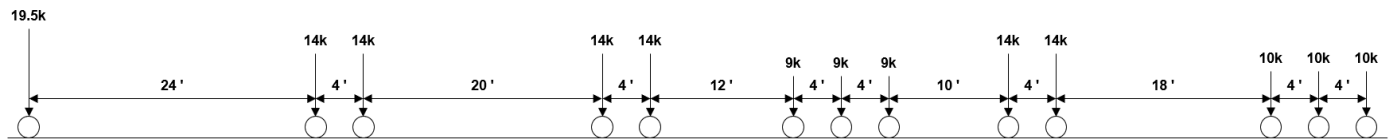
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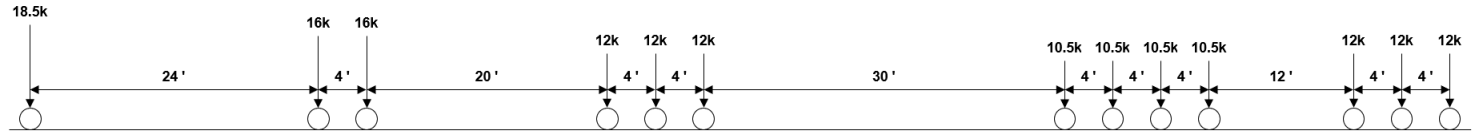
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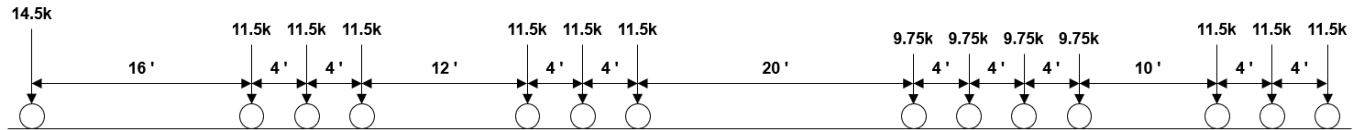
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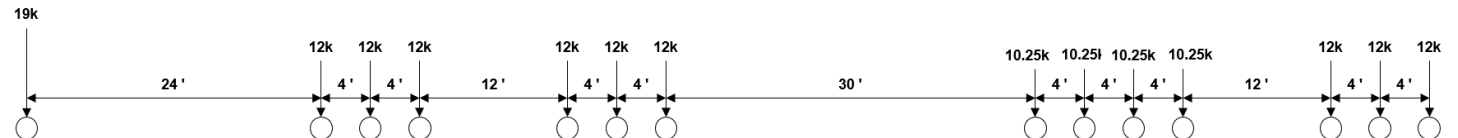
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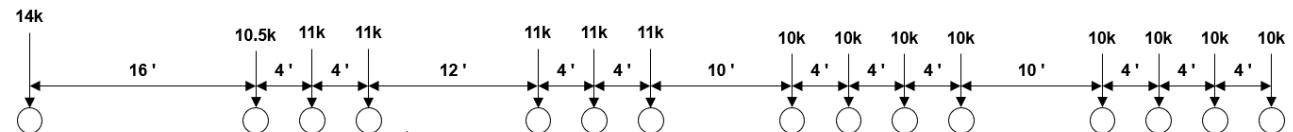
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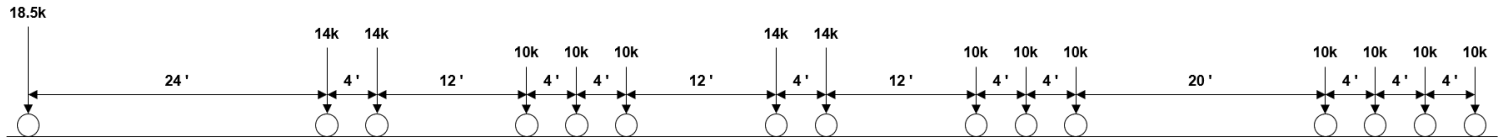
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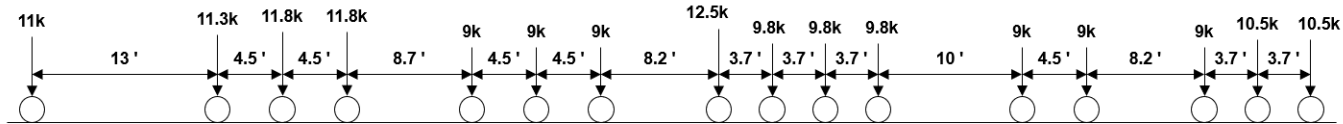
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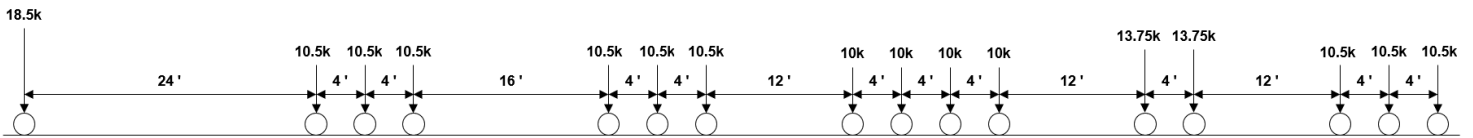
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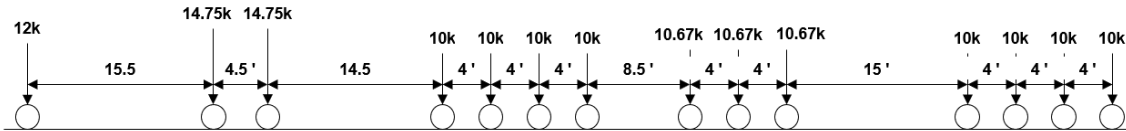
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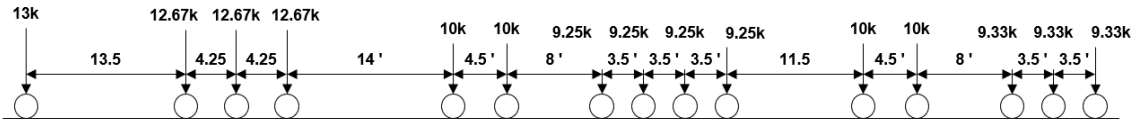
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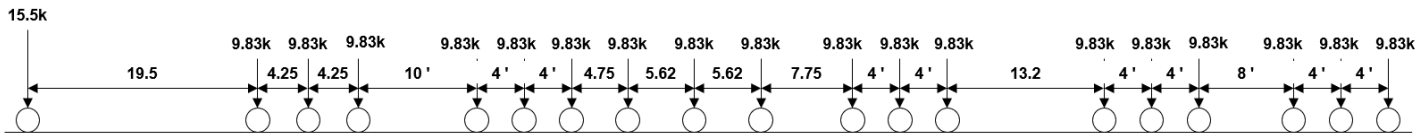
Candidate #61



Candidate #62

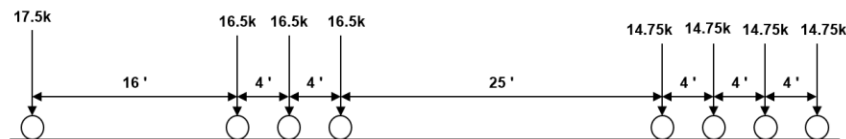


Candidate #63

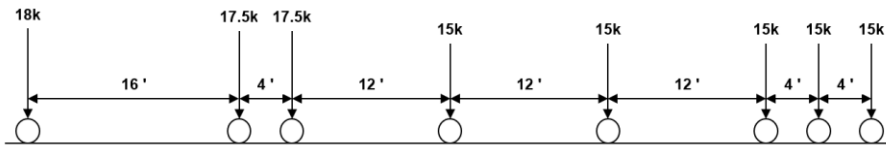


Candidate #64

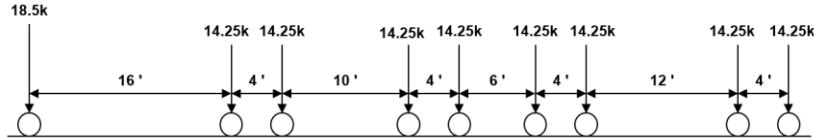
Alaska Routine Permit Combination Vehicles



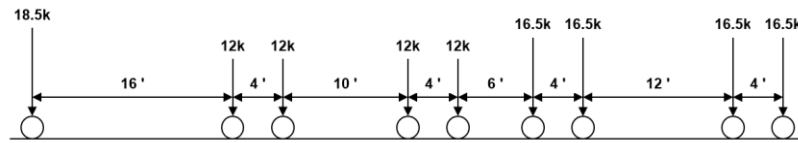
Routine Permit Candidate #32



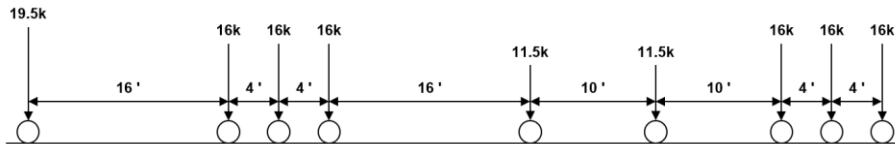
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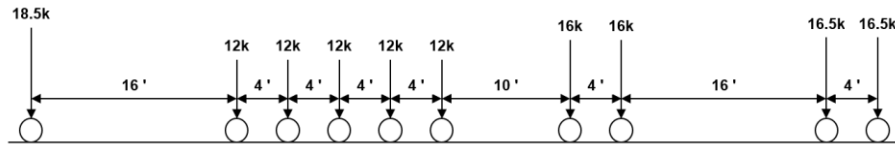
Routine Permit Candidate #36



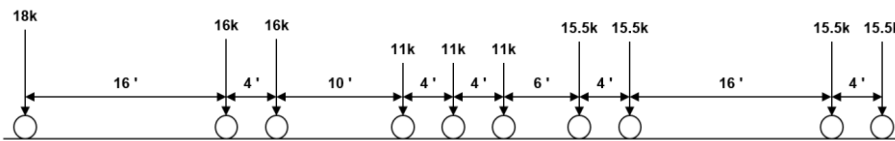
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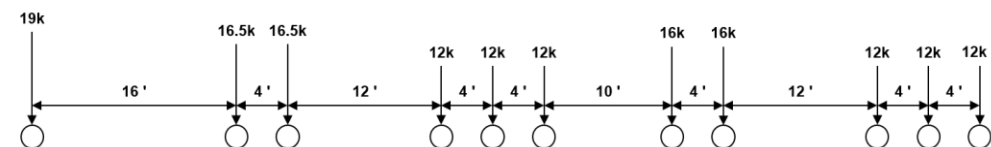
Routine Permit Candidate #38



Routine Permit Candidate #40



Routine Permit Candidate #41



Routine Permit Candidate #44