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Jordan Michael Pelphrey for the degree of Master of Science in Civil Engineering presented on June 16, 2006.

Title: An Investigation of Oregon Weigh-In-Motion Data for Bridge Rating Implementation and Evaluation.

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The LRFR Manual, within commentary Article C6.4.4.2.3, contains provisions for development of site-specific live load factors. In Oregon, truck Weigh-in-Motion (WIM) data were used to develop live load factors for use on state-owned bridges. The factors were calibrated using the same statistical methods that were used in the original development of LRFR. This procedure maintains the nationally accepted structural reliability index for evaluation, even though the resulting state-specific live load factors were smaller than the national standard. The first part of this report describes the jurisdictional and enforcement characteristics in the state, the modifications used to described the alongside truck population based on the unique truck permitting conditions in the state, the WIM data filtering, sorting, and quality

control, as well as the calibration process, and the computed live load factors. Large WIM data sets from four sites were used in the calibration and included different truck volumes, seasonal and directional variations, and WIM data collection windows. Finally, policy implementation for actual use of the factors and future provisions for maintenance of the factors are described.

For bridge rating and evaluation, notional truck models are commonly used to simulate the load effects produced by the truck population. The recently developed Load Resistance and Factor Rating (LRFR) Bridge Evaluation Manual was calibrated based on the 3S2 truck configuration as the notional model. Using GVW as the parameter for establishing live load factors to reflect load effects may not necessarily provide consistent outcomes across all bridge span lengths, indeterminacies, or specific load effects. This is because the load effects are dependent on the distributions of the axle weights, the axle spacing, and the number of axles, in addition to the span geometry and support conditions.

The Oregon Department of Transportation currently uses a suite of 13 rating vehicles for evaluation of their bridge inventory. The load effects for Oregon's bridge rating vehicles have also been calculated for various span lengths and support conditions in the second part of this report. These load effects, both unfactored and factored, were compared with load effects calculated using vehicles from large sets of WIM data. Further, because no established standard of time or quantity of WIM data has previously been recognized, a separate study was conducted in order to determine an acceptable window of WIM data. The objective of this analysis was to determine if the load effects and the live load factors developed for bridge rating produced by the suite of vehicles envelope load effects produced by an acceptable window of collected vehicle data for a variety of bridge span lengths and types. Observations and suggestions are made based on the results of these analyses.

An Investigation of Oregon Weigh-In-Motion Data for Bridge Rating Implementation and Evaluation

by
Jordan Michael Pelphrey

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I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

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Dr. Christopher Higgins assisted with the data interpretation and writing of Chapters 2 and 3. Bala Sivakumar assisted with the data implementation and writing of Chapter 2. The Oregon Department of Transportation assisted with the writing of Chapter 2.

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General Introduction

Oregon allows vehicle loads and configurations on the state highways that are different from many other states. Many of the vehicles are above the federal legal weight limit but are allowed on the highways under permits. Oregon bridge design and rating have relied on national models that are based on data collected in other countries and states. This data may not accurately reflect the loads found in Oregon.

The Oregon Department of Transportation (ODOT) collects data on vehicle weight and axle spacing lengths at WIM scale locations throughout the state. Using this data, analyses were performed to:

- Calculate Oregon-specific live load factors for rating following the methodology in the Manual for Condition Evaluation and Load and Resistance Factor Rating (LRFR) of Highway Bridges;
- Establish an appropriate window of WIM data by extrapolation;
- Evaluate the current ODOT bridge rating vehicles;
- Evaluate the Motor Carrier Transportation Division (MCTD) weight tables;
- Evaluate Oregon's permit classifications.

State-Specific LRFR Live Load Factors Using Weigh-in-Motion Data

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Abstract

The LRFR Manual, within commentary Article C6.4.4.2.3, contains provisions for development of site-specific live load factors. In Oregon, truck Weigh-in-Motion (WIM) data were used to develop live load factors for use on state-owned bridges. The factors were calibrated using the same statistical methods that were used in the original development of LRFR. This procedure maintains the nationally accepted structural reliability index for evaluation, even though the resulting state-specific live load factors were smaller than the national standard. This paper describes the jurisdictional and enforcement characteristics in the state, the modifications used to described the alongside truck population based on the unique truck permitting conditions in the state, the WIM data filtering, sorting, and quality control, as well as the calibration process, and the computed live load factors. Large WIM data sets from four sites were used in the calibration and included different truck volumes,

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seasonal and directional variations, and WIM data collection windows. Finally policy implementation for actual use of the factors and future provisions for maintenance of the factors are described.

CE Database subject headings: load factors, bridges, bridge loads, ratings

Introduction and Background

Transportation agencies are beginning to transition from the American Association of State Highway Officials (AASHTO) Manual for Condition Evaluation of Bridges (1994) to the AASHTO Load and Resistance Factored Rating (LRFR) Specifications (2003) for bridge rating and evaluation. The LRFR Specifications extend the limit states design philosophy from AASHTO Load and Resistance Factor Design (LRFD) (2004) to evaluation of existing bridges. Employing structural reliability principles, the Specifications provide the flexibility to provide uniform target safety levels by reducing uncertainty (Minervino *et al.* 2004) and further provide a means of incorporating advancements in analysis methods, load models, and material and member characterization in the evaluation process. For evaluation of existing bridges, site-specific information can be collected to characterize the local uncertainty, rather than relying on generalized information. One area where it is possible to reduce uncertainty is in the live loads through collection and characterization of site-specific traffic data. The generalized load factors given in the LRFR Specifications are representative of bridges nationwide with similar traffic volumes. The LRFR Specifications provide procedures for calculating site-specific load factors using truck weight data collected from weigh-in-motion (WIM) sites that follows the same format used in the derivation of LRFD live load factors. Site-specific load factors are more refined because they are characteristic of a particular bridge site, route, or jurisdiction and reflect the actual truck traffic and likely maximum loadings over the exposure period.

Following the methodology developed in NCHRP Project No. 12-46 (Moses 2001) and incorporated in the LRFR Specifications, live load factors for strength evaluation were developed for state-owned bridges in Oregon using WIM data from sites across the state. Adaptation of the methods was necessary to account for unique characteristics of truck loads and permitting regulations in the state. Live load factors were developed using WIM data from four sites, including state and interstate routes, considering possible seasonal variations, and different WIM data collection windows. This paper describes the analysis methods used to determine the site-specific live load factors based on WIM data, the resulting live load factors, policy implementation, and plans for updating factors in the future.

Live Load Factor Methodology and Analysis

The LRFR Manual provides a procedure for calculating site-specific load factors using truck weight data from WIM sites that follow the format used in the derivation of live load factors contained in the LRFD Specifications. The LRFR approach is to determine the statistics associated with the 3S2 truck population to characterize the uncertainty associated with the alongside truck. The Ontario truck weight data used in calibration of the LRFR specifications were reasonably matched by a 3S2 truck with a normal distribution and a mean of 68 kips and standard deviation of 18 kips. The weight parameters fit the heaviest one-fifth of the truck weight population and it was assumed that the remaining trucks have no influence on the maximum loading events. The maximum loading event for calibration assumes a legal truck or a permit truck in one lane and a random truck (referred to as the alongside vehicle) in the adjoining lane as illustrated in Fig. 1. Therefore, the load factor applied to the permit vehicle depends on the random alongside truck. Live load factors are higher for spans with higher average daily truck traffic (ADTT) and smaller for heavier permitted vehicles. Live load factors for permit loads are smaller compared with legal load rating values to account for the reduced probability of simultaneous crossing events and also reduced likelihood that a permit truck will be significantly overloaded.

In the LRFD calibration, Nowak (1999) showed that the maximum expected lifetime loading in each lane for two-lane loading is 0.85 times the single lane expected maximum lifetime loading. Therefore, in a two-lane loading situation, the extreme occasional overloads that may be present within the various truck categories are not influential in the calibration of live load factors. This also suggests that data for long periods of time to identify such loads would not be very beneficial for calibration purposes. The key to reliable calibration statistics is the quality and not necessarily the quantity of data.

Significant differences in permitting requirements exist in the State of Oregon, compared to other jurisdictions as illustrated in Table 1. These include a higher legal gross vehicle weight (GVW) of 80,000 lbs compared to the national level of 72,000 lbs, large numbers of CTP vehicles, and extended legal weight CTP vehicles to 105,500 lbs on state highways. As a result, the 3S2 truck population statistics alone may not necessarily characterize the alongside truck variability. Therefore, the alongside truck population in Oregon was taken as consisting of legal trucks (Weight Table 1), Extended Weight Table 2 (105,500 lbs maximum) and 98,000-lb CTP vehicles from Weight Table 3. Inclusion of permitted trucks (the CTPs) in the along-side truck population is a conservative departure from past load factor calibration work, but characteristic of the jurisdiction.

WIM data were used to develop the state-specific live load factors based on the characteristic vehicle population in the state. Three major variables were considered in the selection of WIM data. These included length of the WIM data collection window, truck volume, and seasonal variability. Each is described in additional detail below.

WIM Data Collection Windows

Typically, in practice, two-weeks of WIM data are used to compute site specific live load factors; however no established standard of time or quantity of WIM data has previously been established. To assess the effect of different WIM data collection windows on the corresponding live load factors, three different windows of time were considered in each month: 1) data from the entire month, 2) 2 weeks of data from 1^{st} – 14^{th}, and 3) 2 weeks of data from 15^{th} – 28^{th}. Comparisons were made between each of the two-week data windows and further compared with the all-month data windows.

Traffic Volume

There are four highways/interstates of interest in Oregon that collect WIM data. These are Interstate-5, Interstate-84, Oregon State Highway-58, and US Highway-97. From these highways, individual WIM data collection sites were selected based on ADTT volume. The WIM sites chosen are shown in Table 2 and Fig. 2. These sites enabled calculation of live load factors considering different truck volume conditions.

Seasonal Variation

To assess possible variations in the data occurring at different periods of the year, four "seasons" were selected for each WIM site. WIM sites are intended to collect a continuous record of data for vehicles crossing the WIM scales. However, due to local conditions such as roadway construction or hardware or electronics problems, data were not always continuous over an entire month. Therefore, the months selected for analysis were chosen based on availability of complete months of data within each "season." These included: November through January for winter, April for spring, May and June for summer, and October for fall. Some months strayed outside of traditional "seasonal" boundaries, but only when necessary due to noncontinuous data sets. Table 2 lists the specific months from which WIM data were available for each of the sites. Site specific live load factors were computed for each of these timeframes. Data collection for Bend NB did not begin until June, 2005. Therefore, live load factors could not be calculated for spring, but these will be computed as data become available.

WIM data cleaning, filtering, and Weight Table Sorting Methodology

The raw WIM records from each collection site were provided in text format for subsequent data processing. The data were cleaned and filtered to remove records with formatting mistakes, spurious data, and other errors. Error types that were removed in the cleaning process were:

1. Record where the GVW value is equal to 0.0.
2. Record does not follow the general record pattern; this could be any inconsistency in the time stamp, words out of place from the status quo, incomplete records, etc.
3. Records with misplaced characters, such as a letter where a number should be or a number where a letter should be.
4. Record where an individual axle is greater than 50 kips.
5. Record where the speed is less than 10 mph.
6. Record where the speed is greater than 99 mph.

7. Record where the length is greater than 200 ft.
8. Record where the sum of the axle spacing lengths are greater than the length of the truck.
9. Record where the sum of the axle spacing lengths are less than 7 ft.
10. Record where the first axle spacing is less than 5 ft.
11. Record where the # of axles is greater than 13.
12. Record where the GVW is greater than 280 kips.
13. Record where any axle spacing is less than 3.4 ft.
14. Record which has a GVW +/- the sum of the axle weights by more than 7%.
15. Record which has a GVW less than 2.0 kips

Classifying and sorting the WIM data into the appropriate permit weight table classification is a key step in developing site live load factors. Data processing should remove permitted trucks from the WIM data representing the alongside truck population. Two separate sorting methods for the WIM data were investigated and compared. These are defined as "Conventional Sort" and "Modified Sort."

The Conventional Sort method sorts vehicles based on their GVW, axle group weights, and length (GVW + Axle Group Sort). It is the method currently used by the Motor Carrier Transportation Division (MCTD) of ODOT to classify vehicles into Weight Table 1, Weight Table 2, Weight Table 3, Weight Table 4, Weight Table 5, or Table X (the overflow table classification). Permits are issued based on a vehicle's Weight Table classification. This method accounts for the axle weights and spacing in assigning each vehicle to an appropriate Weight Table and assigns more vehicles to higher Weight Tables than the Modified Sort (described subsequently). Proportionately more heavy vehicles that could have been interpreted as "rogue" legal vehicles are assigned to Weight Table 3 and above and are thus considered as legitimate permit vehicles. The sort yields lower coefficients of variation and as seen subsequently yields lower live load factors compared to the Modified Sort. While it is less conservative than the Modified Sort, it is thought to better represent the permitted truck population in Oregon as will be discussed later.

The Modified Sort method sorts vehicles based only on their GVW and rear-to-steer axle length, and it does not account for axle groupings (GVW + Truck Length Sort). The method assigns more vehicles to lower Weight Tables than the Conventional Sort. Proportionately more heavy vehicles that could have been interpreted as legitimate permit vehicles are conservatively assigned to Weight Tables 1 and 2 and are thus considered "rogue" legal vehicles. The sort produces higher coefficients of variation and higher live load factors compared to the Conventional Sort. While it is more conservative, it may unfairly penalize Oregon's regulatory and enforcement policies, than the Conventional Sort.

Oregon has a well established permitting process that contributes to reduced overloads on state highways. These include minimal cost of overweight permits, large numbers of such permits authorized, the ease of access in obtaining them (such as through the Internet), a weight-mile tax that results in lower taxes for loads placed on more axles, development and fostering of the "Trusted Carrier" program which enhances cooperation and load compliance by trucking companies, and the significant enforcement and cost of penalties imposed on vehicles and drivers that are non-compliant. The compliance to weight limits for trucks in Oregon was verified in a study by Strathman and Theisen (2002) that demonstrated there was no statistically significant evidence of overweight truck scale avoidance. Further, there are few detour routes available to skirt scales on the major state highways.

The two different sorting methods were used on the WIM data sets and results are shown in Table 3 for the Weight Table breakdown. The live load factors herein were calculated based on the Conventional Sort method because it better represents the regulatory and enforcement procedures in Oregon. In contrast to some other states where truckers generally know the vehicle GVW but may not know their axle grouping weights, MCTD of ODOT report that Oregon truckers are generally aware of their axle and tandem weights, usually to within 2,000 lbs, which proves beneficial in obtaining a continuous trip permit.

After careful quality control measures and independent checks were performed on the WIM data cleaning, filtering, and sorting routines, statistics were generated based on GVW for the rating truck and the alongside truck using only the top 20% of the truck weight data from each category. This was consistent with the projection of the upper tail of the weight histogram (Nowak 1999; LRFR 2003). Statistical parameters were calculated for the alongside truck population from Weight Tables 1, 2 and CTPs from Weight Table 3. Additionally, statistical parameters were calculated for just the 3S2 truck population. The statistical parameters are reported in Table 4 for the controlling data sets. Using these statistical values, live load factors were determined for each of the ODOT rating vehicles for the different WIM sites, data windows, and seasons.

The LRFR live load factor for rating is given in Equation 39 of NCHRP Report 454, as:

$$\gamma_L = 1.8\frac{W_T}{240} \times \frac{72}{W} \quad [1]$$

where W is the gross weight of vehicle (legal truck or permit truck with units of kips) and W_T is the expected maximum total weight of rating and alongside vehicles, computed as:

$$W_T = R_T + A_T \quad [2]$$

where, R_T is the rating truck and is computed for legal loads as:

$$R_T = W^* + t_{ADTT}\sigma^*_{3S2} \quad [3a]$$

or for permit loads as:

$$R_T = P + t_{ADTT}\sigma^*_{along} \quad [3b]$$

where W^* is the mean value of the top 20% of legal trucks taken from the 3S2 population, σ^*_{3S2} is the standard deviation of the top 20% of legal trucks, P is the weight of permit truck, σ^*_{along} is the standard deviation of the top 20% of the alongside trucks. The alongside truck, A_T, is computed as :

$$A_T = W^*_{along} + t_{ADTT}\sigma^*_{along} \quad [4]$$

where W^*_{along} is the mean of the top 20% of alongside trucks (taken from Weight Tables 1 and 2, as well as CTPs from Weight Table 3 for the Oregon data). In the above expressions, t_{ADTT} is the fractile value corresponding to the number of side-by-side events, N. The number of side-by-side crossings is computed as:

N (legals) = (ADTT) x (365 days/yr) x (Evaluation period) x ($P_{s/s}$) x (% of record) [5a]

N (permits) = (N_P) x (365 days/yr) x (Evaluation period) x ($P_{s/s}$) [5b]

for legal trucks and permit trucks, respectively, where N_P is the number of observed STP in the WIM data extrapolated over the evaluation period and $P_{s/s}$ is the probability of side-by-side concurrence. LRFD and LRFR calibrations assumed a 1/15 (6.7%) probability of side-by-side events for truck passages. This assumption was based on visual observations and is conservative for most sites. Recent WIM studies completed under NCHRP 12-63 indicate much lower multiple-presence probabilities even for very high ADTT sites. In the NCHRP study, very accurate time stamps were collected and analyzed for WIM sites on I-84 in Idaho and I-75 in Ohio to estimate the number side-by-side events over several days in 2004 and 2005. Results showed maximum side-by-side probability of 3.35% for a three-lane site with >5000 ADTT (Ohio) and 1.37% for a two-lane site with >2500 ADTT (Idaho). These calculated probabilities considered all trucks within a headway separation of 60 feet to constitute a side-by-side event. This larger and more conservative definition of headway separation may produce a higher multiple presence but may have a lower total moment on most spans. The I-5 site in the current study is comparable to the three-lane >5000 ADTT site reported above. For the calibration purposes, a 1/30 (3.4%) probability of side-by-side events was adopted as being more representative of likely concurrence for the sites in Oregon. The ADTT values specific to each site were used in calculating the t_{ADTT} statistic and were listed previously in Table 2. The number of permits per day used in calculating the t_{ADTT} statistic was derived from the Conventional Sort method as shown in Table 3. Once the data were sorted according to the ODOT table classification, the number of Weight Table 3 CTP vehicles with 5 axles and GVW less than 99 kips were removed and placed into Weight Table 2, thereby including them as part of the routine traffic stream. The number of permits was then calculated by summing the remaining trucks in Weight Table 3 as well as those in Weight Tables 4, 5, and X, and then dividing by the number of days in the WIM record. This represents the average number of STP vehicles passing the WIM site each day.

Considering a 5 year evaluation period for which the bridge rating would be considered valid the LRFR live load factors were computed for the various sites and an example calculation procedure is shown in the Appendix. The state-specific load factors represent a target beta level corresponding to the Operating level of 2.5.

Live Load Factor Results

The computed live load factors for all sites, for all seasons, and for all ODOT rating vehicles are shown in Fig. 3. The data used for this calibration process included over 930,000 individual WIM records spanning over 4 months of the year and represents significantly more data than was used in the original calibration of the national specifications.

The computed live load factors are intended to replace Table 6-5 and Table 6-6 (upper portion) in the LRFR manual with the Oregon-specific values based on the actual population of trucks on the state highways. Live load factors for ADTT greater than 5000 correspond to the Woodburn NB (I-5) site. Live load factors for ADTT equal to 1500 correspond to the Emigrant Hill WB (I-84) site. Live load factors for ADTT less than 500 correspond to the Lowell WB (OR58) and Bend NB (US97) sites. For each rating vehicle and represented truck traffic volume level, the live-load factors were conservatively chosen as the upper bound of all the factors from each of the four seasons and each of three data sampling periods. These selected live load factors are lower than the values found in the LRFR manual as shown in Tables 5 and 6. ODOT's MCTD issues STPs in large numbers on a routine basis without specific structural review and as a result, they are treated the same as "Routine or Annual" in Table 6 (upper portion of LRFR Table 6-6). Several of the controlling live load factors were shared by more than one season and/or time-frame and illustrates the degree of consistency between data sets over the period considered. Full data sets, statistics, and details are reported by Pelphrey and Higgins (2006).

Significant Findings from Calibration Process

Significant findings based on results of this calibration process are presented below. These include information on seasonal, directional, and traffic-volume variations between sites, interstate versus non-interstate traffic, and WIM data collection windows.

The variation of live load factors for the different seasons at all four sites can be seen in Fig. 3. I-5 Woodburn NB and US97 Bend NB show very little change from season to season, while OR58 Lowell WB and I-84 Emigrant Hill WB show a slight variation between select seasons. The greatest variation for OR58 is for the Oregon Legal Load (2 Weeks, 1^{st} – 14^{th}) from a Summer live load factor of 1.12 to a Fall live load factor of 1.25 (12% change). The greatest variation for I-84 is for the STP-4A (2 Weeks, 15^{th} – 28th) from a Fall live load factor of 1.18 to a Summer live load factor of 1.32 (13% change). Some of these seasonal variations are attributed to movement of construction equipment and agricultural products in the summer and fall.

To investigate if there were directional influences in the calibrated factors, another site – Woodburn SB for January 2005 – was investigated and compared to its counterpart, Woodburn NB. The live load factors for Woodburn NB and SB in each WIM data window during January, 2005 are shown in Table 7. The results show that the computed live load factors were not sensitive to the direction of travel. Interstate traffic produced higher ADTT values, which in turn produced higher live load factors. This follows the national trend of higher live load factors for higher ADTT values. Calibration of the live load factors for different ADTT volume sites across the state permits them to be used statewide for both interstate and non-interstate routes on state-owned bridges.

Live load factors were calculated for three different windows of time in each month: 1) All month, 2) 2 weeks – 1st – 14th, and 3) 2 weeks – 15th – 28th. This was done to determine if results would change significantly if more WIM data were used to develop the factors. As shown in Fig. 3, there was little difference between the WIM data collection windows. This would suggest that reasonable characterization of the WIM sites (even the lower ADTT volume sites) could be made from any two continuous weeks of data within the month of interest. Here, again it is important to note that high quality data is required and not only a large quantity of data.

A sensitivity analysis was performed to determine how changes in the mean and standard deviation values of the alongside vehicles (Weight Tables 1 and 2, and CTP's < 99 kips from Weight Table 3) affect the live load factors. All four sites were investigated for the summer season using the first two weeks of data (1^{st} – 14^{th}). The analysis determined the magnitude of change required in the alongside vehicle mean and standard deviation to result in the live load factor increasing by 0.05. The two statistical parameters were assessed independent of each other (first, changing only the mean for a live load factor change of 0.05, and then changing only the standard deviation for a live load factor change of 0.05). The results of this analysis are shown in Table 8. As seen in this table, the mean would have to change by about 10% for all sites, and the standard deviation by about 15% on the interstates, and approximately 25% on the state highways.

A sensitivity analysis was also performed for the statistics on the 3S2 population. The live load factor for legal vehicles is the only factor affected by these statistics. Results from this analysis were similar to that observed for the alongside vehicle population, except that the standard deviation would have to be more than twice as large as that for the alongside population. Increasing mean GVW indicates a shift in truck weights while an increase in standard deviation indicates higher dispersion in the data. Changes in these parameters may be caused by changes in policy, compliance, or enforcement, and would indicate a need to recalibrate the load factors.

Discussion of Results

As described earlier, calibration of the LRFR specifications was performed using Ontario vehicle weight data of 1975 which were reasonably described by a 3S2 truck with a normal distribution and a mean of 68 kips and standard deviation of 18 kips for the top 20% of the truck weight population. The corresponding parameters for the Oregon weight data, calibrated using large WIM data sets, had higher mean but reduced standard deviations for the alongside truck population at each of the sites. The parameters indicate that there were significantly more overloads in the Ontario random truck data than are present in the Oregon legal loads or in the truck population grouped as the alongside truck. The maximum loading event for the LRFR calibration of load factors was controlled by the overloaded random trucks. It was shown that even when a permit truck of known weight up to 125 kips crosses the bridge, the expected maximum loading is lower compared with the maximum random legal loading event due to the many overloads in the random traffic (Moses 2001). That is, most routine permits do not affect the critical loading, which was governed by the non-permit overloads. The reduced overloads in the Oregon data explain the reduced site-specific load factors. For example, the LRFR live load factor for legal loads is 1.80 for ADTT ≥5000, while the Oregon-specific value is 1.40. Similar reductions in live load factors were seen for lower ADTT ranges, as well as for permit vehicles (Oregon's CTP and STP vehicles). These results are the outcome of the regulatory and enforcement environment in Oregon. The permit issuance and regulatory environment encourages the routine operation at above-legal load levels by means of low-cost continuous trip permits, and inhibit the operation of heavily overloaded "legal" vehicles within the traffic stream. The major factors affecting this condition include low cost and ease of obtaining permits, a weight-mile tax system that encourages loads spread onto more axles, development of the "Trusted Carrier" program that enhances cooperation and load compliance by trucking companies, and significant enforcement and hefty penalties for non-compliance. Previous research showed no statistically significant evidence of overweight truck scale avoidance (Strathman and Theisen 2002). The ability to minimize uncertainties in the truck population through the effective means described above have the effect of reducing the live load factors.

Policy Implementation

The ODOT Bridge Engineering Section plans to implement the AASHTO LRFR Specifications for rating and evaluation of state-owned bridges. The agency expects this implementation will preserve the safety of the traveling public in Oregon and to the greatest extent possible, facilitate the unrestricted movement of freight on Oregon's highways. These stated purposes are best served by assessing the load carrying capacity of Oregon's bridges as accurately as possible, to avoid the unnecessary restriction of freight movements while maintaining the nationally accepted reliability index. The large and diverse WIM data sets used in the live load factor calibration process produced consistent results and allowed establishment of Oregon specific versions of Tables 6-5 and 6-6 in the LRFR

Manual. The results are applicable only to bridges on Oregon's state-owned highway system and provide an operational rating condition corresponding to a reliability index of 2.5. Live load factors from the I-5 Woodburn Northbound site (ADTT of 5500) were taken to represent ADTT ≥ 5000, and factors from the I-84 Emigrant Hill site (ADTT of 1786) were taken to represent ADTT = 1500. The worst case of the factors from the sites on OR 58 at Lowell (ADTT of 581) and US 97 at Bend (ADTT of 607) was taken as representative of ADTT ≤ 500.

The calibrated live load factors described previously were adjusted for use in the ODOT policy implementation. It is recognized that calibrated live load factors in LRFR are merely statistical adjustments to the loads effects to maintain a uniform level of structural reliability and are not traditional amplification load factors, as were used to provide a margin of safety in the AASHTO Standard Design Specifications (2004). However, to assure additional conservatism where the calibration process resulted in very low live load factors, a minimum value of 1.0 was used. Additionally, the statistical calibration process used to compute the live load factors does not provide precision to the 100^{th} decimal place. Therefore, rounding was applied to the live load factors, generally to the next higher 0.05 increment. The final tables for use in Oregon are shown in Tables 9 and 10.

To investigate possible changes in the truck population in the state, at three year intervals starting in 2008 until 2011 and every five years thereafter, ODOT will review the calibration process using two-week windows of WIM data for each of the same four sites for each season, or will follow nationally accepted protocols that may emerge. If the mean or standard deviation values change enough to cause any live load factor to change by 0.05 or greater, based on the sensitivity analysis study, the Federal Highway Administration will be notified and a complete recalibration of the live load factors will be performed. This is a much more stringent standard of calibration data currency than has been applied to the calibration in the LRFR Manual. In addition to these scheduled reviews, the Oregon-specific live load factors will be reviewed any time a significant statutory or administrative rule change occurs in the vehicle permit regulatory structure (how permits are issued and the fine structure for ticketed overloads) or if a significant change occurs in overweight vehicle enforcement procedures.

In the event that a future review or regulatory change triggers a decision to recalibrate the Oregon-specific live load factors, the calibration procedure will be repeated as described in the above methodology, or in accordance with any nationally accepted protocols that may have been established. The revised Oregon-specific live load factors will be applied to all subsequent load ratings. If the new live load factors are higher (more conservative) than before, ODOT will assess the accumulated body of LRFR load ratings and determine a minimum rating factor threshold to warrant re-rating of bridges. Conservatively, this threshold would be set to match the upper bound percentage increase in the calibrated live load factors for any rating vehicle. Any bridges that have rating factors below this threshold will have the load ratings updated and load restrictions applied, as required. Additional detail regarding the implementation plans are reported by Groff (2006).

Conclusions

The first ever state-wide calibration of live load factors for LRFR bridge evaluation and rating has been performed. This calibration employed the methodology described in the LRFR Manual commentary Article C6.4.4.2.3 for development of site-specific live load factors. WIM data were used to develop the live load factors for evaluation and rating of state-owned bridges. The factors were calibrated using the same statistical methods used in the original development of the LRFR Specifications. Due to the unique jurisdictional and enforcement characteristics in the state, modifications were used to described the alongside truck population and conservatively included continuous trip permit vehicles in this population. WIM data were filtered, sorted, and checked for quality as part of the calibration process. Using the statistical data from the four WIM sites with different ADTT volume, at different times of the year, and over different WIM data collection windows, live load factors were computed. The Oregon-specific live load factors were smaller than those in the LRFR Specification. The factors were smaller for the lower volume sites and smaller for the heavier permit trucks. The high volume site showed little seasonal variation, was insensitive to direction of travel, and two-weeks of data were sufficient to produce consistent factors. For the lower volume sites, some seasonal variation was observed with higher load factors during summer and fall due to agricultural and construction transport. In all cases, the largest computed live load factor from each data set was used to describe the WIM site. By employing the procedures used to develop the LRFR Specification, the resulting live load factors maintain the nationally accepted structural reliability index for evaluation, even though the resulting state-specific live load factors were smaller than the national standard. The large WIM data sets used in the state-specific calibration process were significantly larger than that used in the original LRFD or LRFR calibration process. Finally, policy implementation for the Oregon-specific factors included rounding the computed values to the nearest 0.05, set a lower limit of 1.0 for the live load factors, and established provisions for maintenance of the factors into the future.

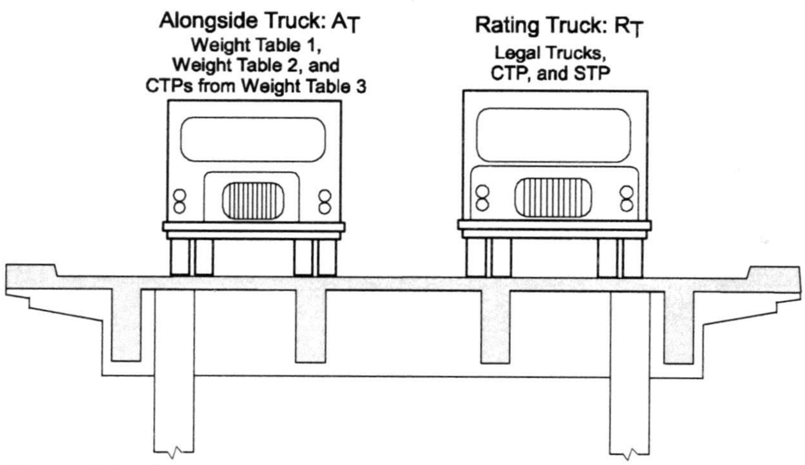

Figure 2.1: Maximum loading event for calibration of live load factors.

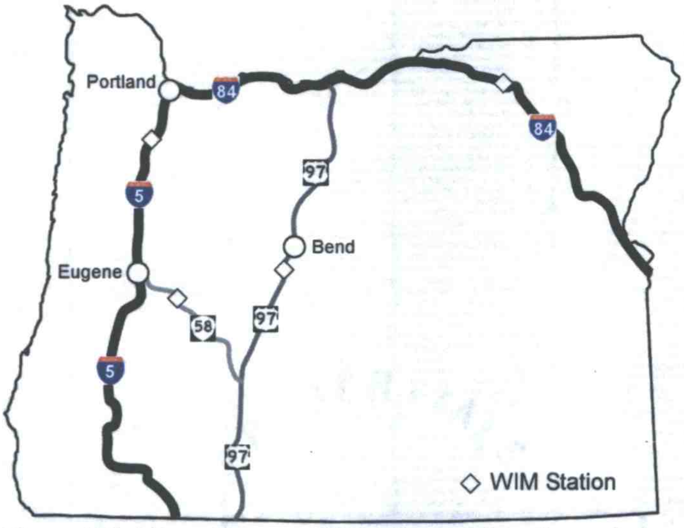

Figure 2.2: Map of Oregon WIM sites used in the study.

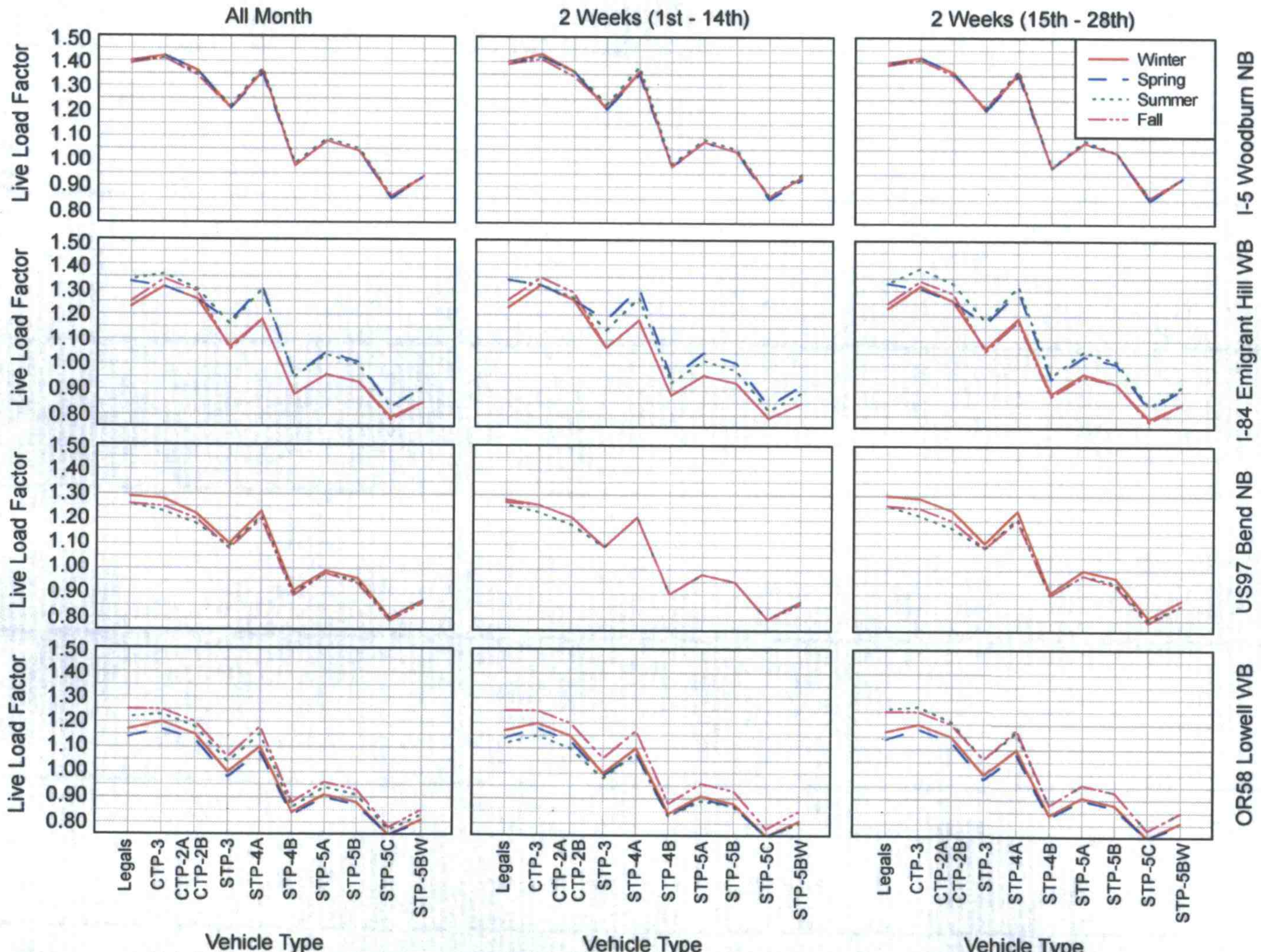

Figure 2.3: Live load factors for WIM sites at different seasons and different WIM data windows.

Table 2.1: ODOT rating vehicle classifications.

Rating Vehicle	Live Load Factor Designation	GVW (kips)
Legal Type 3	Oregon Legal Loads	50
Legal Type 3S2		80
Legal Type 3-3		80
OR-CTP-2A	CTP-2A,2B	105.5
OR-CTP-2B		105.5
OR-CTP-3	CTP-3	98
OR-STP-3	STP-3	120.5
OR-STP-4A	STP-4A	99
OR-STP-4B	STP-4B	185
OR-STP-5A	STP-5A	150.5
OR-STP-5B	STP-5B	162.5
OR-STP-5C	STP-5C	258
OR-STP-5BW	STP-5BW	204

Table 2.2: Selected WIM sites, locations, and ADTT.

Corridor	Site Location	Site Designation	ADTT	ADTT % of ADT	Winter 2005	Spring 2005	Summer 2005	Fall 2005
I-5	Woodburn NB	WBNB	5550	13%	Jan	Apr	June	Oct
US97	Bend NB	BNB	607	8%	Dec	-	June	Oct
OR58	Lowell WB	LWB	581	7%	Jan	Apr	June	Oct
I-84	Emigrant Hill WB	EHWB	1786	36%	Nov	Apr	May	Oct

Table 2.3: Results of sorting methods for Weight Table classification.

Season	Site	Sort Method+	Table 1	Table 2	Table 3	Table 4	Table 5	Table X	Total Records	CTP from WT3 to WT2$	STP Per Day*
Winter	I-5 WBNB	C	124062	13175	1788	44	1	32	139102	477	45
		M	125014	13690	366	29	2	1	139102		
	US97 BNB	C	9776	411	398	9	0	1	10595	185	7
		M	9954	535	105	1	0	0	10595		
	OR58 LWB	C	15157	469	30	3	0	0	15659	4	1
		M	15164	477	17	1	0	0	15659		
	I-84 EHWB	C	43416	2224	72	2	0	0	45714	14	2
		M	43447	2253	14	0	0	0	45714		
Spring	I-5 WBNB	C	136364	13065	1835	57	1	25	151347	609	44
		M	137374	13554	392	21	2	4	151347		
	US97 BNB	C	-	-	-	-	-	-	0	-	-
		M	-	-	-	-	-	-	0		
	OR58 LWB	C	17455	433	17	3	0	0	17908	3	4
		M	17460	442	6	0	0	0	17908		
	I-84 EHWB	C	37249	3433	7177	73	2	77	48011	3688	121
		M	39846	5964	2191	9	1	0	48011		
Summer	I-5 WBNB	C	143018	13684	4713	89	4	47	161555	1938	97
		M	145524	15001	1004	19	6	1	161555		
	US97 BNB	C	15676	763	2304	9	1	20	18773	1616	24
		M	16640	1811	314	7	1	0	18773		
	OR58 LWB	C	24765	954	95	12	1	3	25830	45	2
		M	24813	982	32	3	0	0	25830		
	I-84 EHWB	C	45109	4206	1057	13	0	8	50393	596	16
		M	45450	4563	378	0	0	0	50393		
Fall	I-5 WBNB	C	135964	12136	3912	93	14	46	152165	1436	85
		M	137776	13298	1025	47	19	0	152165		
	US97 BNB	C	18028	708	304	12	4	11	19067	117	7
		M	18167	831	60	7	2	0	19067		
	OR58 LWB	C	25235	1278	202	9	1	13	26738	141	3
		M	25388	1309	36	5	0	0	26738		
	I-84 EHWB	C	48426	3084	49	0	0	1	51560	10	1
		M	48447	3101	12	0	0	0	51560		

+: C= Conventional sort, M=Modified Sort

$: CTP from WT3 to WT2 are records of CTP trucks in Weight Table 3 that were moved into Weight Table 2 to be included in the alongside truck population.

*: STP per day computed as total number of vehicles in Weight Tables 3 (minus the CTPs moved into Weight Table 2), 4, 5, and X divided by the number of days in the month.

Table 2.4: Statistics from controlling WIM data sets used in live load factor calibration.

Vehicle	Statistic	Site			
		I-5 WBNB	I-84 EHWB	US97 BNB	OR58 LWB
Legals (Type 3, 3S2, 3-3)	W^*	75.06	71.32	76.66	69.17
	σ^*_{3S2}	1.98	3.40	1.25	2.93
	W^*_{along}	83.90	80.84	80.78	75.79
	σ^*_{along}	9.73	8.53	8.38	8.46
CTP-3	W^*_{along}	84.01	80.82	80.78	75.79
	σ^*_{along}	9.85	10.23	8.38	8.46
CTP-2A CTP-2B	W^*_{along}	84.01	80.82	80.78	75.79
	σ^*_{along}	9.85	10.23	8.38	8.46
STP-3	W^*_{along}	83.90	80.82	80.78	75.79
	σ^*_{along}	9.73	10.23	8.38	8.46
STP-4A	W^*_{along}	83.90	80.82	80.78	76.11
	σ^*_{along}	9.73	10.23	8.38	8.04
STP-4B	W^*_{along}	83.90	80.82	80.78	75.79
	σ^*_{along}	9.73	10.23	8.38	8.46
STP-5A	W^*_{along}	83.90	80.82	80.78	75.79
	σ^*_{along}	9.73	10.23	8.38	8.46
STP-5B	W^*_{along}	83.90	80.82	80.78	75.79
	σ^*_{along}	9.73	10.23	8.38	8.46
STP-5C	W^*_{along}	83.90	80.82	80.78	75.79
	σ^*_{along}	9.73	10.23	8.38	8.46
STP-5BW	W^*_{along}	83.90	80.82	80.78	75.79
	σ^*_{along}	9.73	10.23	8.38	8.46

Table 2.5: Computed Oregon-specific live load factors for legal loads and LRFR Table 6-5 values.

Traffic Volume (one direction)	Load Factor	
	LRFR	Oregon-Specific
Unknown	1.80	1.40
ADTT ≥5000	1.80	1.40
ADTT = 1500	1.67	1.34
ADTT ≤500	1.51	1.30

Table 2.6: Computed Oregon-specific live load factors for permit loads and upper portion of LRFR Table 6-6 values.

Permit Type	Frequency Condition	Loading Condition	DF	Permit Vehicle	Live load Factor γ_L by ADTT (one direction) > 5000 LRFR	> 5000 Oregon-Specific	= 1500 LRFR	= 1500 Oregon-Specific	< 500 LRFR	< 500 Oregon-Specific
Continuous Trip (Annual)	Unlimited Crossings	Mix w/traffic (other vehicles may be on the bridge)	2 or more lanes	CTP-2A	1.75	1.36	1.58	1.33	1.45	1.24
				CTP-2B	1.75	1.36	1.58	1.33	1.45	1.24
				CTP-3	1.80	1.43	1.63	1.39	1.49	1.29
Single Trip	Route-Specific Limited Crossings	Mix w/traffic (other vehicles may be on the bridge)	2 or more lanes	STP-3	1.60	1.23	1.46	1.18	1.35	1.11
				STP-4A	1.80	1.38	1.63	1.32	1.49	1.24
				STP-4B	1.30	0.99	1.21	0.96	1.14	0.91
				STP-5A	1.30	1.09	1.21	1.06	1.14	1.00
				STP-5B	1.30	1.05	1.21	1.02	1.14	0.97
				STP-5C	1.30	0.86	1.21	0.84	1.14	0.81
				STP-5BW	1.30	0.95	1.21	0.92	1.14	0.88

Table 2.7: Directional influence for live load factors at the I-5 Woodburn NB and SB sites for January, 2005.

Location	Time-Frame	Legals	CTP-3	CTP-2A/2B	STP-3	STP-4A	STP-4B	STP-5A	STP-5B	STP-5C	STP-5BW
I-5 WBNB	All Month	1.40	1.42	1.36	1.21	1.36	0.98	1.08	1.04	0.85	0.94
I-5 WBSB	All Month	1.39	1.42	1.36	1.22	1.37	0.98	1.09	1.05	0.86	0.94
I-5 WBNB	1st - 14th	1.40	1.43	1.36	1.21	1.36	0.98	1.08	1.04	0.86	0.94
I-5 WBSB	1st - 14th	1.38	1.42	1.36	1.22	1.37	0.98	1.08	1.04	0.86	0.94
I-5 WBNB	15th - 28th	1.40	1.42	1.36	1.21	1.36	0.98	1.08	1.04	0.85	0.94
I-5 WBSB	15th - 28th	1.39	1.43	1.36	1.23	1.38	0.99	1.09	1.05	0.86	0.95

Table 2.8: Sensitivity analysis for alongside vehicle variability for select rating vehicles during summer season (2 Weeks - 1st - 14th).

Site Info		Original Statistics*		Increase W to Increase γ_L by 0.05		Increase σ to Increase γ_L by 0.05	
		W (kips)	σ (kips)	W (kips)	% Change	σ (kips)	% Change
I-5 WBNB	Legals γ_L = 1.40 to 1.45	83.9	9.7	91.3	9%	11.5	18%
	CTP-3 γ_L = 1.42 to 1.47	83.9	9.7	93.0	11%	10.9	12%
	STP-4A γ_L = 1.38 to 1.43	83.9	9.7	93.1	11%	11.0	13%
US97 BNB	Legals γ_L = 1.26 to 1.31	81.7	6.5	89.1	9%	8.5	31%
	CTP-3 γ_L = 1.23 to 1.28	81.7	6.5	90.8	11%	7.9	21%
	STP-4A γ_L = 1.21 to 1.26	81.7	6.5	90.7	11%	7.9	22%
OR58 LWB	Legals γ_L = 1.12 to 1.17	68.2	6.3	75.6	11%	8.3	32%
	CTP-3 γ_L = 1.15 to 1.20	68.2	6.3	77.3	13%	7.7	22%
	STP-4A γ_L = 1.08 to 1.13	68.2	6.3	77.4	13%	8.2	30%
I-84 EHWB	Legals γ_L = 1.34 to 1.39	80.8	8.5	88.2	9%	10.4	22%
	CTP-3 γ_L = 1.32 to 1.37	80.8	8.5	89.9	11%	9.8	15%
	STP-4A γ_L = 1.27 to 1.32	80.8	8.5	90.0	11%	10.0	17%

*Statistics derived from WT1, WT2, & CTP's < 99.0k from WT3 (alongside vehicle)

Table 2.9: ODOT Adaptation of LRFR Table 6-5 Generalized Live-Load Factors for Legal Loads: γ_L

	Liveload Factor γ_L by ADTT[a] (one direction)[b]			
Traffic Volume (one direction)	Unknown	≥5000	= 1500	≤500
Liveload Factor γ_L	1.40	1.40	1.35	1.30

Notes:

[a] Interpolate the Liveload Factor by ADTT values. Liveload Factors from this table should not be used when advanced methods of analysis are employed.

[b] If there are two directions of traffic, use only half of the structure ADTT to determine the Liveload Factors.

Table 2.10: ODOT adaptation of upper portion of LRFR Table 6-6 for ODOT Routine Permits.

Permit Type	Frequency	Loading Condition	DF[a]	Permit Vehicle	Liveload Factor γ_L by ADTT[b] (one direction)[c]			
					Unknown	≥5000	= 1500	≤500
Continuous Trip (Annual)	Unlimited Crossings	Mix w/traffic (other vehicles may be on the bridge)	2 or more lanes	CTP-2A	1.35	1.35	1.35	1.25
				CTP-2B	1.35	1.35	1.35	1.25
				CTP-3	1.45	1.45	1.40	1.30
Single Trip	Route-Specific Limited Crossings	Mix w/traffic (other vehicles may be on the bridge)	2 or more lanes	STP-3	1.25	1.25	1.20	1.10
				STP-4A	1.40	1.40	1.35	1.25
				STP-4B	1.00	1.00	1.00	1.00
				STP-5A	1.10	1.10	1.05	1.00
				STP-5B	1.05	1.05	1.05	1.00
				STP-5C	1.00	1.00	1.00	1.00
				STP-5BW	1.00	1.00	1.00	1.00

Notes:

[a] DF = LRFD Liveload Distribution Factor. When one-lane distribution factor controls for an exterior girder, the built-in Multiple Presence Factor for one lane (1.2) should be divided out of the Distribution Factor.

[b] Interpolate the Liveload Factor by ADTT values. Liveload Factors from this table should not be used when advanced methods of analysis are employed.

[c] If there are two directions of traffic, use only half of the structure ADTT to determine the Liveload Factors.

[d] DF = LRFD Liveload Distribution Factor. When a one-lane Distribution Factor is used, the built-in Multiple Presence Factor for one lane (1.2) should be divided out of the Distribution Factor.

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APPENDIX A

Appendix A

Example Calculation of Live Load Factors

The following section provides a detailed example for calculating live load factors. Data from the I-5 Woodburn NB site for June 2005 (2 weeks, 1st – 14th) is used to illustrate the procedure. Live load factors are calculated for Oregon Legal Loads, CTP-2A, CTP-2B, CTP-3, and STP-3. The statistics used in demonstration of the calculation for the live load factors are shown in Table A1.

Table A2.1: Statistics for I-5 Woodburn NB, June 2005 (2 weeks, 1st - 14th)

Vehicle	Using the Top 20% of the WIM Record		
	Max GVW	Mean W^*	σ^*
3S2 - Legal	80^K	75.1^K	2.0^K
Alongside Truck	105.5^K	83.9^K	9.7^K

1) Load Factor for Oregon Legal Loads.

Using a 1/30 probability of side-by-side events for two legal trucks, a 5 year evaluation period, an ADTT=5550, and taking the top 20% of the record; the number of side-by-side events N:

$N = (5550)(365)(5)(1/30)(1/5) = 67{,}525$
$1/N = 1.4809\text{x}10^{-5}$

From NCHRP 454, Appendix A: $t_{ADTT} = 4.18$

$R_T = 75.1 + 4.18\text{x}2.0$
$= 83.3^K$

$A_T = 83.9 + 4.18\text{x}9.7$
$= 124.5^K$

$W_T = 83.3^K + 124.5^K$
$= 207.8^K$

$$\gamma_L = 1.8 \times \frac{207.8}{240} \times \frac{72}{80}$$

= **1.40** → This is the controlling value for ADTT ≥5000

2) Load Factors for Continuous Trip Permits (CTP).

ODOT has estimated that CTPs are about 30% of legal truck traffic on I-5 for determining the number of side-by-side events, N (CTP adjacent to a legal truck).

N = 67525 x 0.30 = 20258
$1/N = 4.9364 \times 10^{-5}$

From NCHRP 454, Appendix A: $t_{ADTT} = 3.89$

$A_T = 83.9 + 3.89X9.7$
$= 121.8^K$

a) For 105.5^k CTP (CTP-2A/2B)

$R_T = 105.5 + 3.89X9.7$
$= 143.4^K$

$W_T = 143.4^K + 121.8^K$
$= 265.2^K$

$$\gamma_L = 1.8 \times \frac{265.2}{240} \times \frac{72}{105.5}$$

= **1.36** → This is the controlling value for ADTT ≥5000

b) For 98^k CTP (CTP-3A)

$R_T = 98 + 3.89X9.7$
$= 135.9^K$

$W_T = 135.9^K + 121.8^K$
$= 257.7^K$

$$\gamma_L = 1.8 \times \frac{257.7}{240} \times \frac{72}{98}$$

= **1.42**

3) <u>Load Factor for 120.5^K STP-3 (same method for all STP vehicles)</u>

From Table 3, $N_P = 97$:

$N = (97)(365)(5)(1/30) = 5901$
$1/N = 1.6947 \times 10^{-4}$

From NCHRP 454, Appendix A: $t_{ADTT} = 3.58$

$A_T = 83.9^K + 3.58x9.7^K$
$= 118.8^K$

$R_T = 120.5 + 34.7$
$= 155.4^K$

$W_T = 155.4^K + 118.8^K$
$= 274.1^K$

$$\gamma_L = 1.8 \times \frac{274.1}{240} \times \frac{72}{120.5}$$

= **1.23** → This is the controlling value for ADTT ≥5000

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Evaluation of Bridge Rating Vehicles Using Weigh-In-Motion Data

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Abstract

For bridge rating and evaluation, notional truck models are commonly used to simulate the load effects produced by the truck population. The recently developed Load Resistance and Factor Rating (LRFR) Bridge Evaluation Manual was calibrated based on the 3S2 truck configuration as the notional model. LRFR also permits development of site-specific live-load factors and provides a methodology for their calculation based on GVW of the local truck population. Using GVW as the parameter for establishing live load factors to reflect load effects may not necessarily provide consistent outcomes across all bridge span lengths, indeterminacies, or specific load effects. This is because the load effects are dependent on the distributions of the axle weights, the axle spacing, and the number of axles, in addition to the span geometry and support conditions.

The Oregon Department of Transportation currently uses a suite of 13 rating vehicles for evaluation of their bridge inventory. Live load factors were developed for this suite of trucks, based on weigh-in-motion (WIM) measured GVW data from sites located across the state. The load effects for Oregon's bridge rating

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vehicles have been calculated for various span lengths and support conditions. These load effects, both unfactored and factored, were compared with load effects calculated using vehicles from large sets of WIM data. Further, because no established standard of time or quantity of WIM data has previously been recognized, a separate study was conducted in order to determine an acceptable window of WIM data. The objective of this analysis was to determine if the load effects and the live load factors developed for bridge rating produced by the suite of vehicles envelope load effects produced by an acceptable window of collected vehicle data for a variety of bridge span lengths and types. Observations and suggestions are made based on the results of these analyses.

CE Database Subject Headings: bridges, analysis, bridge loads, ratings, load factors

Introduction

For bridge rating and evaluation, notional truck models are commonly used to simulate the load effects produced by the truck population. The recently developed Load and Resistance Factor Rating (LRFR) Bridge Evaluation Manual was calibrated based on the 3S2 truck configuration, as the notional model. The LRFR manual also permits development of site-specific live-load factors and provides a methodology for their calculation based on the gross vehicle weight (GVW) of the local truck population. Using GVW as the parameter for establishing live load factors to reflect load effects may not necessarily provide consistent outcomes across all bridge span lengths, indeterminacies, or specific load effects. This is because the load effects are dependent on the distributions of the axle weights, the axle spacing, and the number of axles (Kim *et al.* 1997), in addition to the span geometry and support conditions.

The Oregon Department of Transportation currently uses a suite of 13 rating vehicles for evaluation of their bridge inventory. Recently, live load factors were developed for this suite of trucks, based on weigh-in-motion (WIM) measured GVW data from sites located across the state, as reported in Pelphrey and Higgins (2006). To supplement that study, the load effects for Oregon's bridge rating vehicles have been calculated for various span lengths and support conditions. These load effects, both factored and unfactored, were compared with load effects calculated using vehicles from large sets of WIM data. Further, because no established standard of time or quantity of WIM data has previously been recognized, a separate study was conducted in order to develop recommended WIM data collection windows. The objective of this analysis was to determine if the load effects and the live load factors developed for bridge rating produced by the suite of vehicles envelope load effects produced by an acceptable window of collected vehicle data for a variety of bridge span lengths and types. Observations and suggestions are made based on the results of this analysis.

Background

Oregon allows vehicle loads and configurations on the state highways that are different from many other states. Many of the vehicles are above the federal legal weight limit but are allowed on the highways under permits. Oregon bridge design and rating have relied on national models that are based on data collected in other countries and states. This data may not accurately reflect the loads found in Oregon.

The Oregon Department of Transportation (ODOT) collects data on vehicle weight and axle spacing lengths at WIM scale locations throughout the state. Using this data, analyses were performed to establish an appropriate window of WIM data necessary to reasonably extrapolate future loading events, evaluate the current ODOT bridge rating vehicles, the Motor Carrier Transportation Division (MCTD) weight tables, and permit classifications. The current ODOT rating vehicles are shown and illustrated in Table 1. Also shown in Appendix A are the five MCTD weight tables.

Each of the ODOT rating vehicles was previously selected by MCTD to be representative of one the five MCTD weight tables, as shown in the right column of Table 1. There are at least two rating vehicles for each weight table, which attempt to capture the range of load effects produced within the weight tables, although no previous analysis has been performed to validate them.

WIM Data

WIM data is collected at various sites along Oregon's interstate and highway systems. It is the process of collecting vehicle weight and axle configuration while the vehicle is moving (Daniels, 2004). The WIM system is designed to monitor and record individual characteristics for each passing vehicle. These include the date and time, type/class of vehicle as classified by ODOT, lane position, speed, gross vehicle weight, overall length, equivalent single axle load (ESAL) value, total number of axles, overall axle weights, left axle weight, right axle weight, axle spacing lengths relative to each other, and the allowable axle weights according to MCTD's Weight Table 1. Some of the records include additional markings like "TAG_H: 000545968675", which designate that the vehicle is equipped with a transponder for use in Oregon's Green Light (Preclearance) Program (Fifer, 2005). Fig. 1 shows an example of a WIM recorded vehicle event.

There is a ± 2-3% error rate as a result of the fluctuation of weight distribution due to the vehicle being in motion (Fifer, 2002). This error is most evident for vehicles hauling liquids, livestock, and for log trucks without middle supports (Daniels, 2004).

WIM data are divided up into two types, REALTIME and raw. The analysis herein focuses on the raw data format. Data are recorded continuously to a text file, which is stored on a hard drive located at the site. This data is retrieved monthly and posted on an ftp server for download.

Cleaning and Filtering the WIM Data

In order to use the raw WIM data, a considerable amount of pre-processing must take place. Once downloaded from the ftp site, the data must be reformatted for use in subsequent analyses and cleaned to remove erroneous records. Two FORTRAN programs were written to accomplish this task: Wingnut and Liger. The Wingnut program formats the data according to a specified fixed-width and stores it to a new file. This program also filters out some of the obvious errors that are encountered. The Liger program cleans the data from Wingnut. It reads the new text file created by the Wingnut program and filters out spurious data. It checks all vehicle records to make sure they contain realistic numerical values (vehicle-specific criteria) and are free from invalid characters (such as letters where numbers should be, etc.). A detailed justification summary of the Liger program, as well as documented quality control checks for processing the WIM data, can be found in Appendix B.

Cleaning and filtering of the raw WIM data were performed to remove the following:

1. Record where the gross vehicle weight (GVW) value is equal to 0.0.
2. Record does not follow the general record pattern; this could be any inconsistency in the time stamp, words out of place from the status quo, incomplete records, etc.

3. Records with misplaced characters, such as a letter where a number should be or a number where a letter should be.
4. Record where an individual axle is greater than 50 kips.
5. Record where the speed is less than 10 mph.
6. Record where the speed is greater than 99 mph.
7. Record where the length is greater than 200 ft.
8. Record where the sum of the axle spacing lengths are greater than the length of the truck.
9. Record where the sum of the axle spacing lengths are less than 7 ft.
10. Record where the first axle spacing is less than 5 ft.
11. Record where the # of axles is greater than 13.
12. Record where the GVW is greater than 280 kips.
13. Record where any axle spacing is less than 3.4 ft.
14. Record which has a GVW +/- the sum of the axle weights by more than 7%.
15. Record which has a GVW less than 2.0 kips.

After both of these programs have been executed on the WIM data file, the results are then used for sorting and analysis.

WIM Site Selection

There are currently five highways/interstates in Oregon which are collecting WIM data: I-5, I-84, OR58, US26, and US97. From these highways, one individual site was selected for load effect analysis – I-5 Booth Ranch NB. The two criteria in choosing this site were the volume of average daily truck traffic (ADTT), and the amount of available continuous raw WIM data. The WIM site chosen is shown circled in Fig. 2. A complete breakdown of the WIM sites located throughout the state can be found in Appendix C.

Previous research has shown that high ADTT sites produce higher live load factors due to the increased likelihood of side-by-side concurrence (Moses 2001, Pelphrey & Higgins 2006). Thus, a site was selected for this analysis that had a relatively high ADTT in order to capture the upper tail of the vehicle population. The I-5 Booth Ranch NB site was selected in part because it matched this criteria. Only I-5 Woodburn NB, I-5 Woodburn SB, and I-84 Cascade Locks EB have higher ADTT values. I-5 Booth Ranch NB was selected over these three sites because of the amount of available continuous raw WIM data, as explained in the next paragraph. The ADTT for I-5 Booth Ranch NB is shown in Table 2, along with other pertinent information (Fifer, 2005).

The site selected for this analysis had a complete and continuous year of raw WIM data. Only one other site, I-5 Ashland NB, contained data for the entire year of 2005. I-5 Booth Ranch NB was selected because the ADTT was greater than that of I-5 Ashland NB (ADTT of 2979). A summary of the measured vehicle traffic mix is presented in Table 3. Figure 3 presents a frequency histogram of the number of axles per vehicle. Data are included for all vehicles captured by the WIM scale at I-5 Booth Ranch NB for each month in 2005. There were a total of 981,226 valid WIM vehicles passing the site over the entire year.

Weight Table Sorting Methodology

Classifying and sorting the WIM data proved to be an important issue. Two separate WIM data sorting methods were investigated and compared to one another. These are the Conventional Sort method and the Modified Sort method.

1. Conventional Sort ("GVW + Axle Group Sort")

   - This method sorts vehicles based on their GVW, axle group weights, and length. It is the method currently used by the Oregon Department of Transportation to classify vehicles as Weight Table 1, Weight Table 2, Weight Table 3, Weight Table 4, Weight Table 5, or Table X (the overflow table classification). Permits are issued based on a vehicle's Weight Table classification.
   - It accounts for the axle spacing in assigning each vehicle to the appropriate Motor Carrier Transportation Division (MCTD) Weight Table.
   - It assigns more vehicles to higher Weight Tables than the Modified Sort (described subsequently) based on the axle weights.
   - Proportionately more heavy vehicles that could have been interpreted as "rogue" legal vehicles are assigned to Weight Table 3 and above and are now considered as legitimate permit vehicles.
   - It yields lower coefficients of variation compared to the Modified Sort.

- It yields lower live load factors compared to the Modified Sort (Pelphrey & Higgins, 2006).
- It is less conservative, but is thought to better represent the permitted truck population in Oregon, than the Modified Sort.

2. Modified Sort ("GVW + Truck Length Sort")

- This method sorts vehicles based only on their GVW and rear-to-steer axle length, and it does not account for axle groupings.
- Assigns more vehicles to lower Weight Tables than the Conventional Sort.
- Proportionately more heavy vehicles that could have been interpreted as legitimate permit vehicles are conservatively assigned to Weight Tables 1 & 2 and are thus considered "rogue" legal vehicles.
- It yields higher coefficients of variation compared to the Conventional Sort.
- It yields higher live load factors compared to the Conventional Sort (Pelphrey & Higgins, 2006).
- It is more conservative, but may unfairly penalize Oregon's well established, easily and simply available, and inexpensive permitting process, than the Conventional Sort.

Table 4 compares the Weight Table breakdown for each sorting method. The load effect analysis herein is based on the Conventional Sort method because it better represents the permitted truck population in Oregon. In contrast to some other states where truck drivers generally know the vehicle GVW but may not know their axle grouping weights, MCTD and ODOT report that Oregon truckers are generally aware of their axle and tandem weights, usually to within 2,000 lbs, which proves beneficial in obtaining a continuous trip permit (CTP) (Groff, 2006).

By comparing the number of Table X vehicles in the Conventional Sort to those of the Modified Sort, it is apparent that heavy axle groups control this vehicle classification. Because ODOT reviews all Table X vehicles internally by structural analysis, it is unlikely that there are over 800 real Table X vehicles crossing the site. This realization might infer that there are more rogue vehicles in the system than previously anticipated. However, previous data collection at a larger volume site, I-5 Woodburn NB, revealed that there were roughly 450 Table X vehicles by the Conventional Sort method for one year (Pelphrey & Higgins, 2006). The large number of Table X vehicles also might be related to the percent of error associated with the WIM equipment in capturing accurate individual axle weights, and the sensitivity of the weight table classifications to the individual axle groups. Nowak and Ferrand report that the accuracy is ± 20 percent for axle loads (Nowak and Ferrand, 2004). Another explanation for the large number of Table X vehicles may be a result of not imposing the two Weight Table 1 exceptions in the original sort routines. The first exception allows two consecutive tandem axles to weigh up to 34,000 pounds each if the minimum axle spacing between tandems is 30 feet or more with a permit, or 36 feet or more without a permit. The second exception allows a group of four axles consisting of a set of tandem axles and two axles spaced nine feet or more apart to have a loaded weight more than 65,000 pounds and up to 70,000 pounds if the minimum axle spacing is 35 feet or more with a permit. The minimum axle spacing refers to the distance between the first and last axle of the group. All vehicles were sorted without regard to these exceptions. Because the Table X vehicles are not represented by a specific rating vehicle, they were compared with the operating level HL-93 configuration of the LRFR manual.

Selecting an Appropriate Window of Data

Typically, in practice, two-weeks of continuous WIM data are used for various types of analysis; however no established standard of time or quantity of WIM data has previously been recognized. For example, as shown by Nowak and Hong 1991, Nowak 1993, LRFD 1994, and Nowak 1999, the live-load model used in the Load Resistance and Factor Design (LRFD) bridge design code was calibrated using roughly 2 weeks of WIM data. Also, as shown in Moses 2001, LRFR 2003, and Minervino and others 2004, the live load factors used in the LRFR bridge rating manual were calibrated using the same 2 weeks of WIM data. Therefore, in order to determine an acceptable window of WIM data, a separate study was conducted. This study investigated the top 20 percent of selected WIM data according to vehicle GVW with increasing windows of time. A complete year of WIM data for both a high-volume (I-5 Booth Ranch NB, ADTT = 3442) and a low-volume site (US 97 Klamath Falls NB, ADTT = 769) were analyzed. The projection windows for both sites began with June 1st, 2005. The projection periods included 2-day, 7-day, 14-day, 30-day, 60-day, 120-day, 1-year, and 5-year extrapolation lengths. For each projection window, the data was plotted as a cumulative distribution function (CDF) (A detailed description of the CDF function is described in the following section, "Load Effect Procedure"). A best fit line was applied to the upper tail of each CDF. Each line was then extrapolated out to the selected projection periods to determine an estimated maximum GVW. Fig. 4 and 5 plot each of the seven projection periods with corresponding extrapolation lines for I-5 Booth Ranch NB and US 97 Klamath Falls NB, respectively. The equations represented by the extrapolation lines are shown on each plot. Projected GVW values were solved for by using these equations. Tables 5 and 6 show the maximum projected GVW values for each projection time window and corresponding statistical parameters, respectively, for I-5 Booth Ranch NB. Tables 7 and 8 show the maximum projected GVW values for each projection time window and corresponding statistical parameters, respectively, for US 97 Klamath Falls NB. Fig. 6 and 7 show the projected GVW values graphically for I-5 Booth Ranch NB and US 97 Klamath Falls NB, respectively.

The results for the high ADTT site, I-5 Booth Ranch NB, show a steady decrease in extrapolated GVW values for increasing time windows, as shown in Table 5. For example, using 2 days of data, the 5-year extrapolation GVW is 349.5 kips, while using 7 days of data, the same extrapolation GVW is 318.2 kips. This trend is the same for all windows of time at this site. The percent change values between each of the adjoining windows of time are also shown in Table 5. The percent change between 2 and 7 days, and 7 and 14 days is greater than or equal to 9%. Then, between 14 and 30 days and following, the percent change decreases to a constant ~ 4-6%. This would suggest that an appropriate window of time for this site for collection of WIM data would be between 14 and 30 days. This criterion was met and exceeded for the load effect portion of this study by using one full year of data. The coefficient of variation for each window of time was a constant 12%, as shown in Table 6.

The results for the low ADTT site, US 97 Klamath Falls NB, generally show a steady decrease in extrapolated GVW values for increasing time windows, as shown in Table 7. Only one time window, the 7 days of data window, does not follow the expected trend. This can be seen more clearly in Fig. 7. The percent change between 2 and 7 days is ~ -25%, and between 7 and 14 days is ~ +25%. The extrapolation values for the 7-day window might show a significant decrease because of the abnormally low standard deviation, which produces a higher slope, as shown in Table 8. The percent change between adjoining windows of time levels out between 14 and 30 days. This would suggest that an appropriate window of time for this site for analyzing data would be 30 days. This criterion is again met and exceeded for the load effect portion of this report by using one full year of data.

From the results presented, it is recommended that at least 14-30 days of data at a high-volume site be used for WIM data analysis. Low-volume sites typically require longer windows of time to capture load effects represented in the upper tail. Also, as shown above, a low-volume site does not produce the same level of consistency as a high-volume site and when making decisions over an entire network, it is recommended to use the highest volume site.

Calculation of Load Effects

Once the data for each month was cleaned, filtered, and sorted according to the MCTD Weight Table classifications, it was used to compute load effects in a suite of bridges. The maximum shears and moments were computed for each of the 981,226 WIM records at selected locations for specified spans and span lengths. Four simply supported span lengths were analyzed: 50-ft, 100-ft, 150-ft, and 200-ft. For this study, shear values on the simply supported spans were calculated at a distance 4 ft from the support, and moment values were calculated at midspan. These locations were selected to capture the maximum load effects for each span length. Fig. 8 shows the locations of the selected points for the simple span configuration. A two-span continuous bridge model with 50-ft span lengths, typical of 1950's vintage reinforced concrete deck girder bridges (Higgins *et al.* 2004), was also analyzed. Negative moment was evaluated at the center support, while shear was evaluated at a distance 4-ft to the left of the center support, as shown in Fig. 9.

In order to obtain an accurate projection of the upper tail of the WIM load effect histogram, only the largest 20 percent of all vehicle load effects were considered as the basis for fixing the vehicle load effect spectrum (Moses, 2001). Statistical data are presented in the form of cumulative distribution functions (CDF). This scale is used to present and compare the critical upper tails. The distributions were plotted on normal probability paper (Laman and Nowak, 1993). Two different CDF's were plotted (as shown in the next section, "Graphical Results") on each graph. The first CDF represents the top 20 percent of all vehicles for the entire year. The second CDF represents the top 20 percent of 3S2 vehicles for the entire year. In this study, a 3S2 vehicle was defined in the following way: five-axle vehicle with no specified maximum GVW, with the first axle spacing greater than 5.5 ft, second axle spacing less than 5.5 ft, third axle spacing greater than 5.5 ft, and the fourth axle spacing less than 5.5 ft.

The CDF's were plotted on normal probability paper for moments and shears for each of the span lengths and types. The vertical scale, z, is,

$$z = \Phi^{-1} [F(x)] \quad [1]$$

where F(x) = cumulative distribution function of x, where x is the moment M or shear V; Φ^{-1} = inverse of the standard normal distribution function. More information about the inverse of the standard normal distribution function can be found in Nowak 1999, Nowak and Collins 2000, and Haldar and Mahadevan 2000.

Since bridge ratings are typically evaluated at 5-year intervals, a 5-year projection was used. A line of best fit was applied to the tail end of each CDF. Each line was then extrapolated out to the 5-year line to determine the estimated maximum load effect. Let N be the total number of vehicles in time period T. The number of vehicles in the top 20 percent of the record at I-5 Booth Ranch NB for 2005 was 196,247. Because the WIM data represents one year of traffic, the number of vehicles, N, in T = 5 years will be 981,235. The probability level corresponding to N is 1/N, and for N = 981235, it is 1/981235 = 1.02×10^{-8}, which corresponds to z = 4.75 on the vertical scale, as shown on each plot as the upper solid, horizontal line. The same approach was applied for the 3S2 vehicles, with a corresponding z = 4.41, as shown on each plot as the lower solid, horizontal line.

The rating vehicles, along with the HL-93 loading configuration, and AASHTO's four Notional Rating Load (NRL) vehicles, were also analyzed for each of the span configurations. The NRL vehicles were derived from the Federal Highway

Administration's "Specialized Hauling Vehicles", and represent short and heavy Legal vehicles. They were adopted at the 2005 AASHTO Bridge Meeting and will appear as an optional rating load in the 2006 LRFR Interim. Pictograms for the NRL vehicles can be found in Appendix A. Maximum moments and shears were calculated and are represented on each plot as vertical lines. Two plots were created for each span length and load effect: the first with unfactored rating vehicles and the second with factored rating vehicles.

Oregon-Specific Live Load Factors

Following the methodology developed in NCHRP Project No. 12-46 (Moses 2001) and incorporated in the LRFR Specifications, live load factors for strength evaluation were developed for state-owned bridges in Oregon using WIM data. Adaptation of the methods was necessary to account for unique characteristics of truck loads and permitting regulations in the state. Live load factors were developed using WIM data from four sites, including state and interstate routes, considering possible seasonal variations, and different WIM data collection windows (Pelphrey & Higgins, 2006). The computed live load factors represent the two lanes loaded case only. They account for the vehicle under consideration, for example, a Type 3S2 Legal vehicle or any of the vehicles depicted in Table 1, plus a likely alongside vehicle.

The load effects produced by the WIM data were compared to the load effects produced by Oregon's rating vehicles, both factored and unfactored. The factored values were obtained by multiplying the nominal force effect by a corresponding state-specific live load factor, as mentioned above. The live load factors used for the I-5 Booth Ranch NB site conservatively followed the ADTT ≥5000 category, as reported by Pelphrey & Higgins (2006).

Live load factors were also applied to the HL-93 configuration and to the NRL vehicles. Following the procedures of the LRFR, an operating level factor of 1.35 was applied to the HL-93 configuration (section 6.4.3.2.2 of LRFR, 2003). The same live load factor applied to the legal rating vehicles (Weight Table 1) of 1.40 was used for the NRL vehicles (Groff, 2006).

Maximum load effects corresponding to longer periods of time were calculated by extrapolation of the vehicle WIM data. The CDF representing all of the vehicles was used to calculate extrapolated load effects. These results are compared to the factored HL-93 (operating level) loading configuration, as shown in Table 9. Most of the ratio values are close to 1.0, with the majority exceeding 1.0. The operating level for the HL-93 loading configuration represents the 5-year extrapolation load effects produced by the WIM vehicles reasonably well.

Tabular and Graphical Results

Fig. 10 shows the CDF plot for unfactored moment for the 100-ft simple span bridge model and the corresponding Weight Table breakdown plots. Fig. 11 shows the CDF plot for factored moment for the 100-ft simple span bridge model and the corresponding Weight Table breakdown plots. Plots for both unfactored and factored moments and shears for all span types and lengths are shown in Appendix D.

Table's 10 and 11 show all results for simple span shear and moment, respectively. Table 12 shows the load effects for the two-span continuous model. The columns entitled "Ratio" describe whether or not the load effects for each rating vehicle exceed that of the highest observed WIM vehicle per table classification. A ratio greater than unity denotes that the rating vehicle adequately envelopes the load effect in question. Shaded values denote a ratio value less than 1.0.

Significant Findings

Significant findings based on results of this analysis are presented below. These include comparisons between the load effects produced by each of Oregon's rating vehicles and the load effects produced by the top 20 percent of traffic for a complete year of WIM data at I-5 Booth Ranch NB.

Unfactored Load Effects

Comparison between the unfactored load effects and the WIM data in Table's 10, 11, and 12 reveal further justification for the use of live load factors. The results show that the unfactored rating vehicles did not produce sufficient demand to represent the service level loads of the WIM data. Further, there was a need to include the likelihood of an alongside truck also being present on the bridge. Live load factors account for this condition using a two-lane loaded calibration. The magnitude of the alongside truck in 3S2 equivalents is shown in Table's 10, 11, and 12 as a percent of 3S2 value. For example, a value of 24 percent means the lane with the rating vehicle receives 100 percent of the load effect from the rating vehicle and also gets 24 percent of the maximum load effect from an alongside vehicle in 3S2 equivalents.

Factored Load Effects

The results show that the factored rating vehicles did a relatively good job providing sufficient demands to envelope the load effects of the WIM data. There were only a few factored rating vehicles at select span lengths that did not exceed the corresponding WIM value. Table 13 identifies the factored rating vehicles which were sufficient and insufficient with respect to the WIM data. It was not necessary for all of the rating vehicles within a table classification to eclipse the load effects of the WIM data. Rather, only one of the representative rating vehicles from each of the Weight Tables was needed to exceed the WIM results to be deemed satisfactory. Ratios in Table 13 that are shaded represent rating vehicles that did not envelope the WIM data.

Rating Vehicle Summary

The factored rating vehicles representing Weight Table 1 effectively cover the load effect spectrum produced by the Table 1 WIM vehicles. All load effects for all span lengths are enveloped by at least one of the three representative vehicles. The Type 3S2 and Type 3-3 Legal vehicles provide sufficient capacity for all load effects analyzed, which suggests the Type 3 Legal vehicle could be eliminated. These vehicles were also fairly consistent with regards to the percent of adjacent 3S2 equivalents for the varying span lengths, which suggests a level of uniform reliability.

The factored rating vehicles representing Weight Table 2 effectively cover the load effect spectrum produced by the Table 2 WIM vehicles. The Type CTP-2A and the Type CTP-2B vehicles produce sufficient factored load effects for all span lengths considered. These vehicles were also fairly consistent with regards to the percent of adjacent 3S2 equivalents for the varying span lengths, which suggests a level of uniform reliability.

The factored rating vehicles representing Weight Table 3 effectively cover the load effect spectrum produced by the Table 3 WIM vehicles. The Type CTP-3 and the

Type STP-3 vehicles produce sufficient factored load effects for all spans considered. The STP-3 vehicle is fairly consistent with regards to the percent 3S2 values for varying span lengths, which suggests a level of uniform reliability. However, the CTP-3 is not as consistent. The percent of 3S2 values are higher for the 50-ft and 100-ft simple spans, then decrease for the 150-ft and 200-ft simple spans, as shown in Table's 10 and 11.

The factored rating vehicles representing Weight Table 4 do not effectively cover the load effect spectrum produced by the Table 4 WIM vehicles. The Type STP-4A vehicle is effective for load effects for span lengths of 50 and 100 ft, but not for span lengths of 150 and 200 ft. The Type STP-4B vehicle is not adequate for moments and shears at any span length. As a result, the load effects for the Weight Table 4 WIM vehicles exceed both rating vehicles for span lengths of 150 and 200 ft. The STP-4B vehicle is fairly consistent with regards to the percent 3S2 values for varying span lengths, which suggests a uniform level of reliability. However, the STP-4A is not as consistent. The percent of 3S2 values are higher for the shorter simple spans, and decrease with span length.

The factored rating vehicles representing Weight Table 5 effectively cover the shear spectrum produced by the Table 5 WIM vehicles, but do not effectively cover the moment spectrum for the 50-ft span. At least one of the Table 5 rating vehicles for all other span types and ranges envelop the WIM load effects. These vehicles are fairly consistent with regards to the percent of 3S2 values for varying span lengths, which suggests a level of uniform reliability. The STP-5BW shows the most consistency, while the STP-5B is the least consistent.

Table X is ODOT's overflow table classification. These are vehicles that fall outside of Weight Table 5, and require axle weight and configuration approval by the ODOT bridge group. Therefore, rating vehicle adequacy does not apply to this classification of vehicles. However, the HL-93 factored at the LRFR operating level exceeded most Table X load effects as described further below.

HL-93 Loading

The operating level HL-93 loading configuration was also compared to the WIM data. It is represented on all CDF plots by a solid vertical line. The factored HL-93 configuration envelopes all exclusion traffic for the surveyed WIM data except for negative moment on the two-span continuous bridge model.

Notional Rating Load Vehicles

The NRL vehicles representing Weight Table 1 effectively cover the load effect spectrum produced by the Table 1 WIM vehicles. All load effects for all span lengths are enveloped by all four representative vehicles, except for the SU4 vehicle for negative moment on the two-span continuous bridge model. However, the implementation of the NRL vehicles as "Legal" vehicles is redundant, as the existing three legal rating vehicles already adequately envelope the WIM load effects. Further, the NRL vehicles produced inconsistent results over the varying span lengths. The current representative AASHTO 3S2 legal vehicle produced more consistent load effects than the NRL vehicles. The percent of adjacent 3S2 load effect values in Table's 10, 11, and 12 vary significantly for the NRL vehicles over the different span lengths and appear to provide nonuniform levels of reliability.

Conclusions and Recommendations

A study was conducted to determine an amount of WIM data needed to extrapolate future loading events for both high and low ADTT volume sites. In a separate study, load effects for ODOT's suite of 13 bridge rating vehicles were calculated for various span lengths and types. These load effects, both factored and unfactored, were compared to the load effects calculated from vehicles in the WIM data. One full year of WIM data was collected, cleaned, filtered, sorted, and analyzed for I-5 Booth Ranch NB, a relatively high-volume ADTT site. The analyses included shear, positive moment, and negative moment values for various span types and lengths. Load effects were plotted as cumulative distribution functions on normal probability paper. Oregon-specific live load factors, developed from previous research, were applied to the lane-load effects for the suite of evaluation vehicles. The analysis presented herein analyzed lane-load effects, and did not consider component-specific effects. Based on the findings, the following conclusions and recommendations are made:

- For a high ADTT volume site (approximately 3500 ADTT), approximately two weeks of WIM data is needed to adequately extrapolate future upper tail events. For a low ADTT volume site (approximately 500 ADTT), one month of WIM data is needed.
- Additional WIM data should be collected and analyzed. One year of data from two sites was used in this study to project loading events to a five year extrapolation window. As additional data become available, two and five years of collected data should be analyzed and results compared to the rating vehicles, and also to the one-year extrapolation values.
- The factored rating vehicles provided reasonably sufficient demands to envelope the load effects of the WIM data, including that attributed to an adjacent equivalent 3S2 alongside vehicle.
- The contribution of the alongside vehicle in 3S2 equivalents for each of the rating vehicles was presented as a percent of the nominal value to examine the consistency of the reliability between varying span lengths and load effects. Most of the factored rating vehicles produced a fairly uniform level of reliability.
- The Oregon-specific live load factors applied to the rating vehicles adequately enveloped the load effects produced by the WIM data. Some of the rating vehicles that are in current use do not quite produce the same

level of demand compared to some WIM vehicles observed on Oregon's state-owned highways. However, the ratios of the rating vehicle load effect to the WIM vehicle load effect that were below 1.0 were reasonably close to 1.0. Considering the level of uncertainty in WIM axle weight measurements, as well as the calibration process, this difference was minor.

- The Type 3 Legal vehicle could be eliminated from the suite of rating vehicles. Additional research should be conducted to further support this recommendation, as stated in subsequent bullets.
- No immediate changes, such as increases in axle weights or reduction of axle spacing lengths, are necessary for the suite of ODOT rating vehicles.
- The use of the NRL vehicles to represent Table 1 vehicle classification in Oregon is redundant, and need not be incorporated into to the suite of rating vehicles. Further, the NRLs provided nonuniform levels of reliability compared with the current Table 1 representative vehicles.
- Only one WIM site was considered in this study for comparison of load effects. Additional analyses should be conducted for other routes in Oregon, with varying ADTT, directionality, and freight corridors taken into account.
- Additional span types and lengths should be analyzed. This may include three-span, four-span, and five-span continuous models with varying span lengths.
- Load effects at the girder level should be calculated and compared for both the WIM data and the rating vehicles using girder distribution factors.

- The factored HL-93 loading (at the operating level) was found to adequately envelope most Table X loading scenarios.

```
(834) LANE A  CLASS 11  GVW 75.4 kips  LENGTH 67 ft
ESAL 3.221 SPEED 61 mph  MAX GVW 80.0 kips Wed Jun 16 00:04:52.40 2004
 AXLE     SEPARATION      LEFT WT      RIGHT WT      TOTAL WT     ALLOWABLE
             (ft)         (kips)        (kips)        (kips)        (kips)
   1                        5.5           5.5          11.1          13.2
   2         16.7           8.4           7.6          16.0          17.0
   3          4.6           7.9           7.7          15.6          17.0
   4         32.4           8.5           7.5          16.0          17.0
   5          4.1           9.1           7.6          16.7          17.0
[OFF]
```

Figure 3.1: Example of raw WIM output.

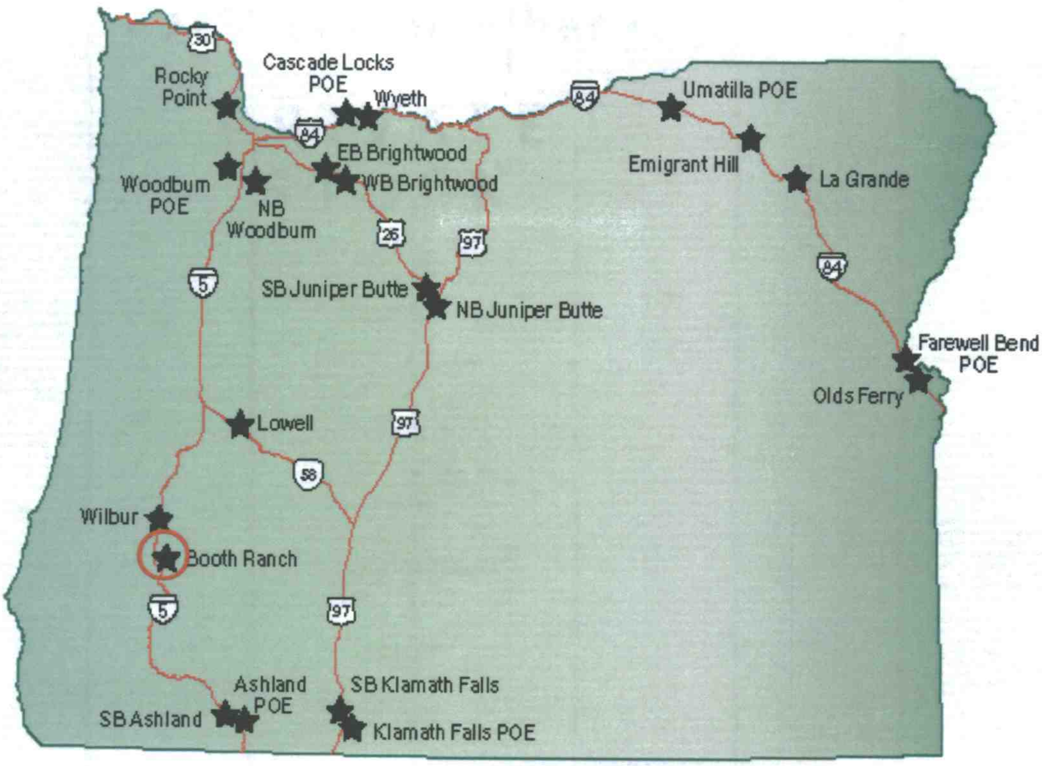

Figure 3.2: Location of I-5 Booth Ranch NB.

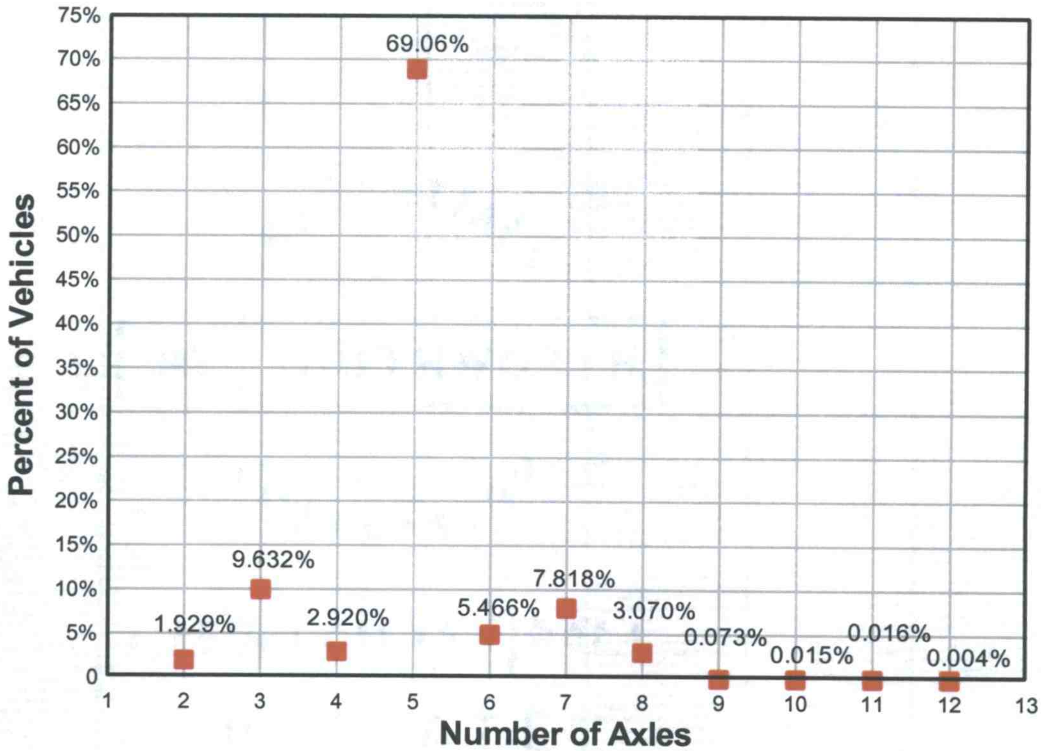

Figure 3.3: Frequency histogram of the number of axles per vehicle.

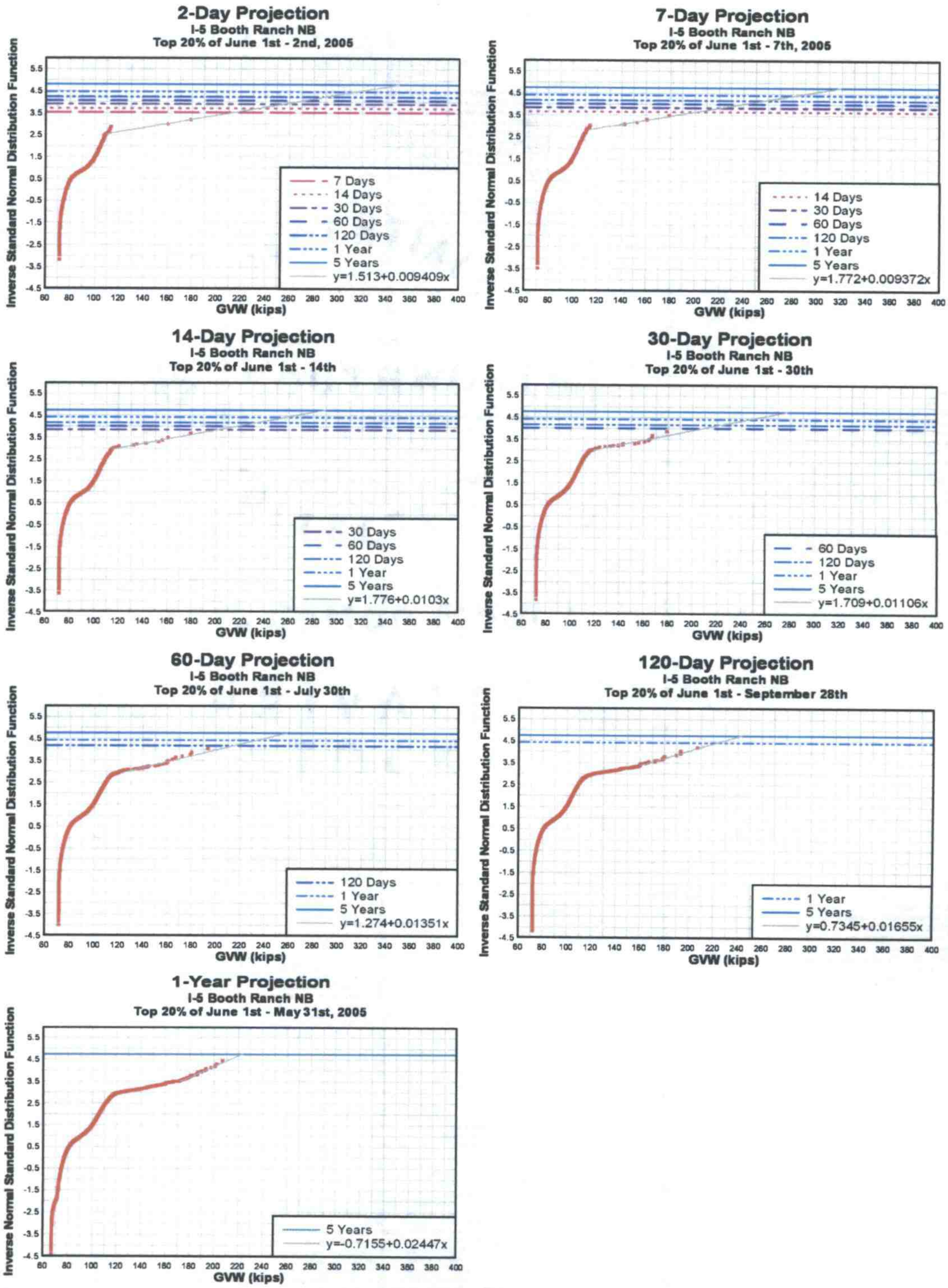

Figure 3.4: Projection plots for various time windows for I-5 Booth Ranch NB.

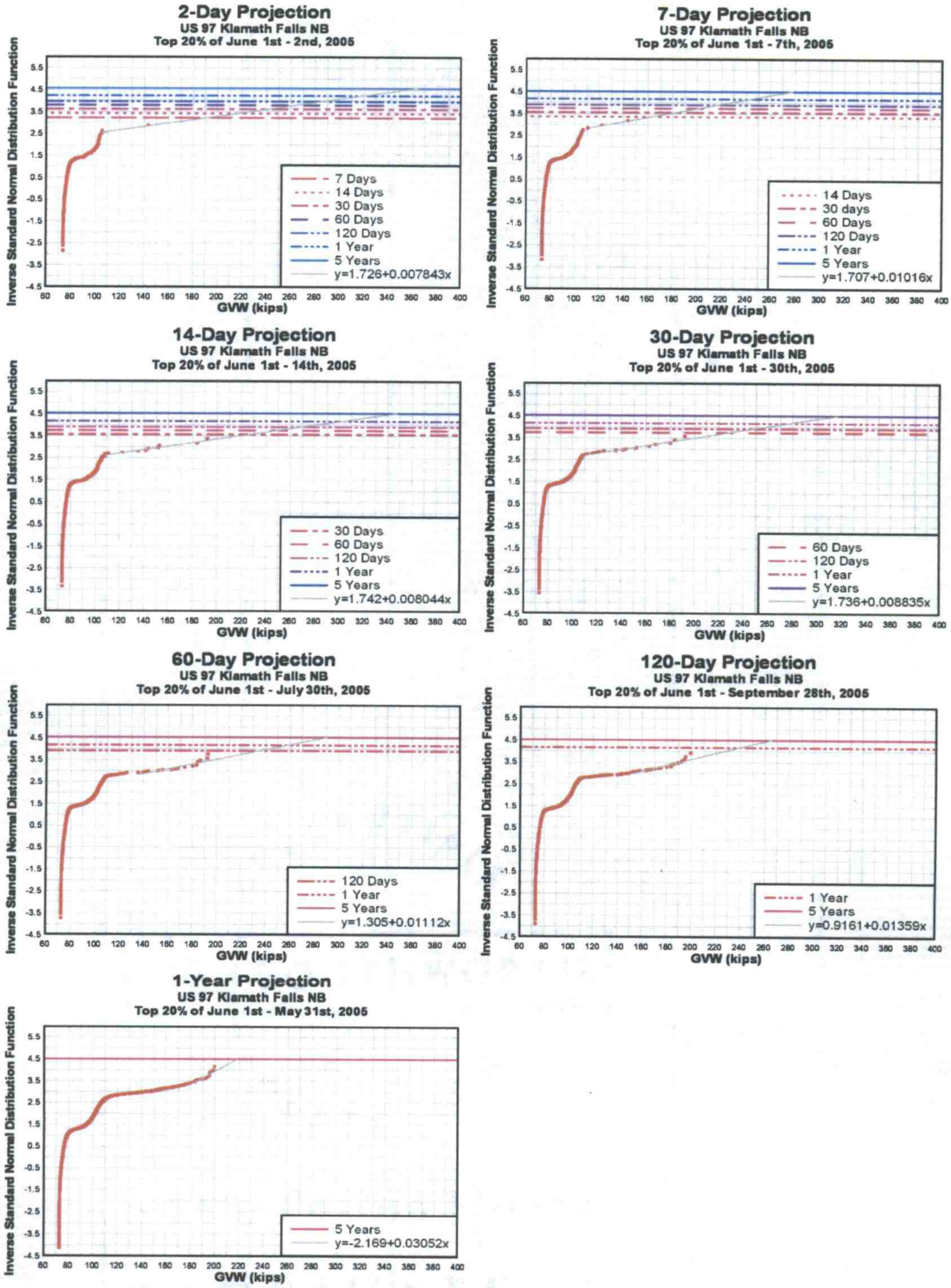

Figure 3.5: Projection plots for various time windows for US 97 Klamath Falls NB.

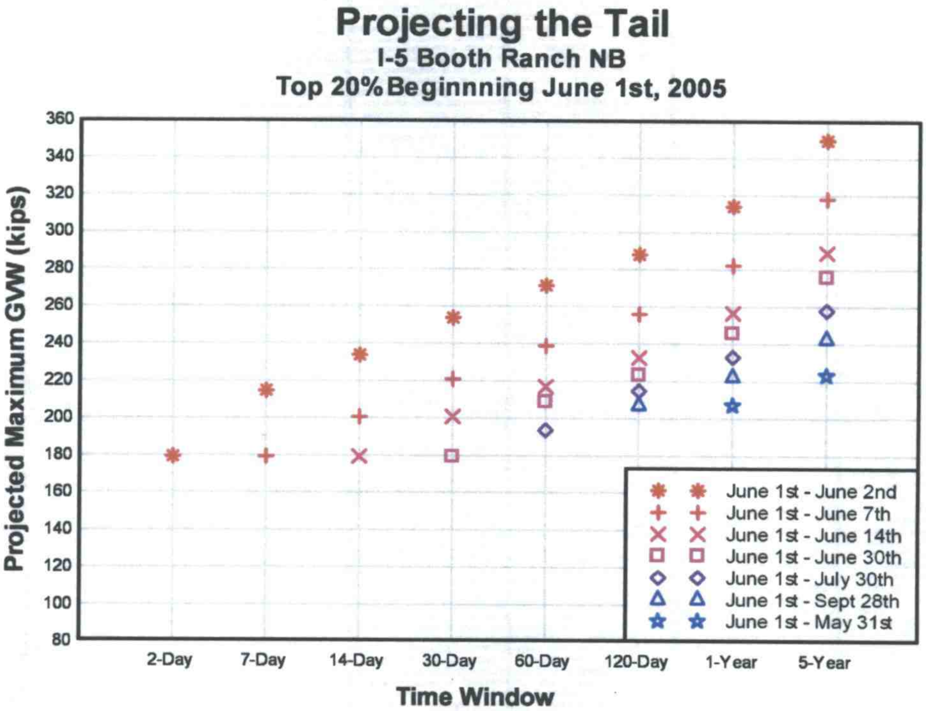

Figure 3.6: Projected GVW values for all time windows for I-5 Booth Ranch NB.

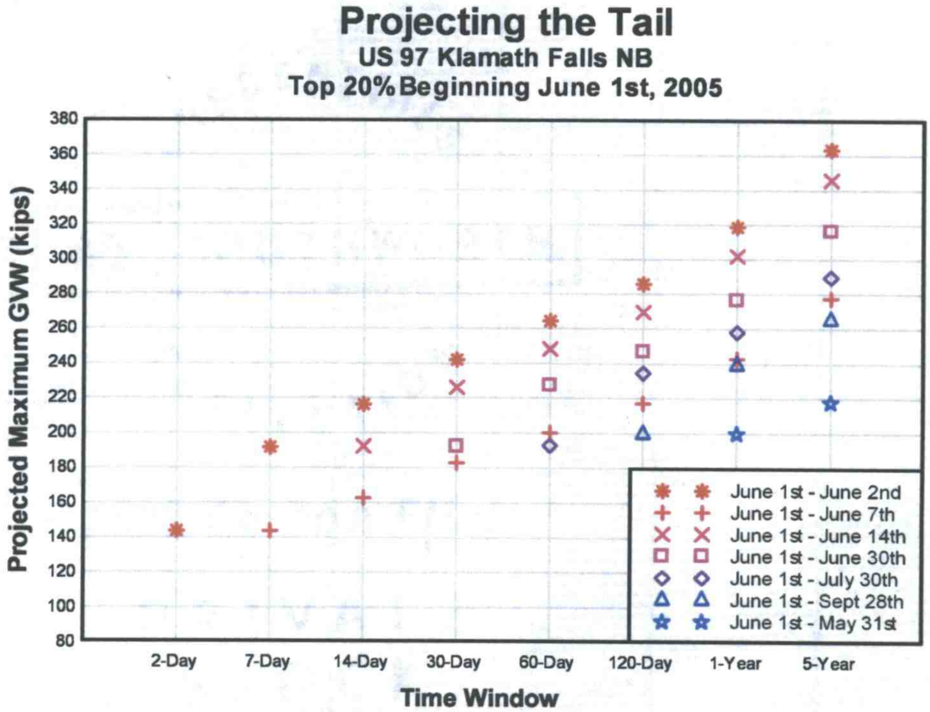

Figure 3.7: Projected GVW values for all time windows for US 97 Klamath Falls NB.

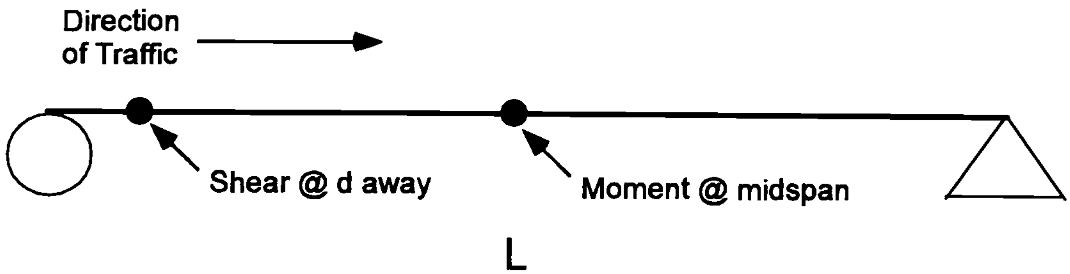

Figure 3.8: Shear & moment locations for simple span analysis.

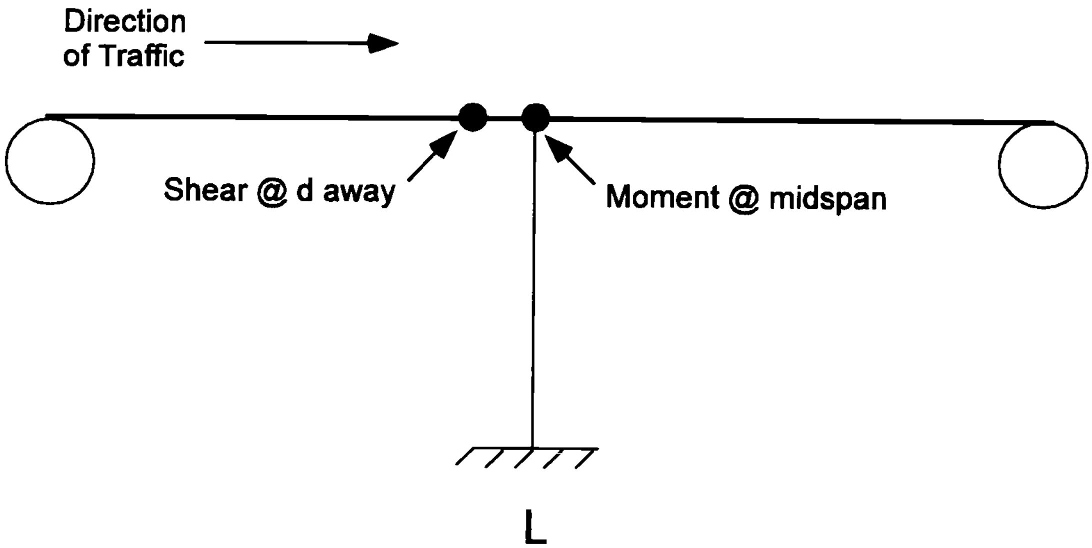

Figure 3.9: Shear & moment locations for 2-span continuous bridge analysis.

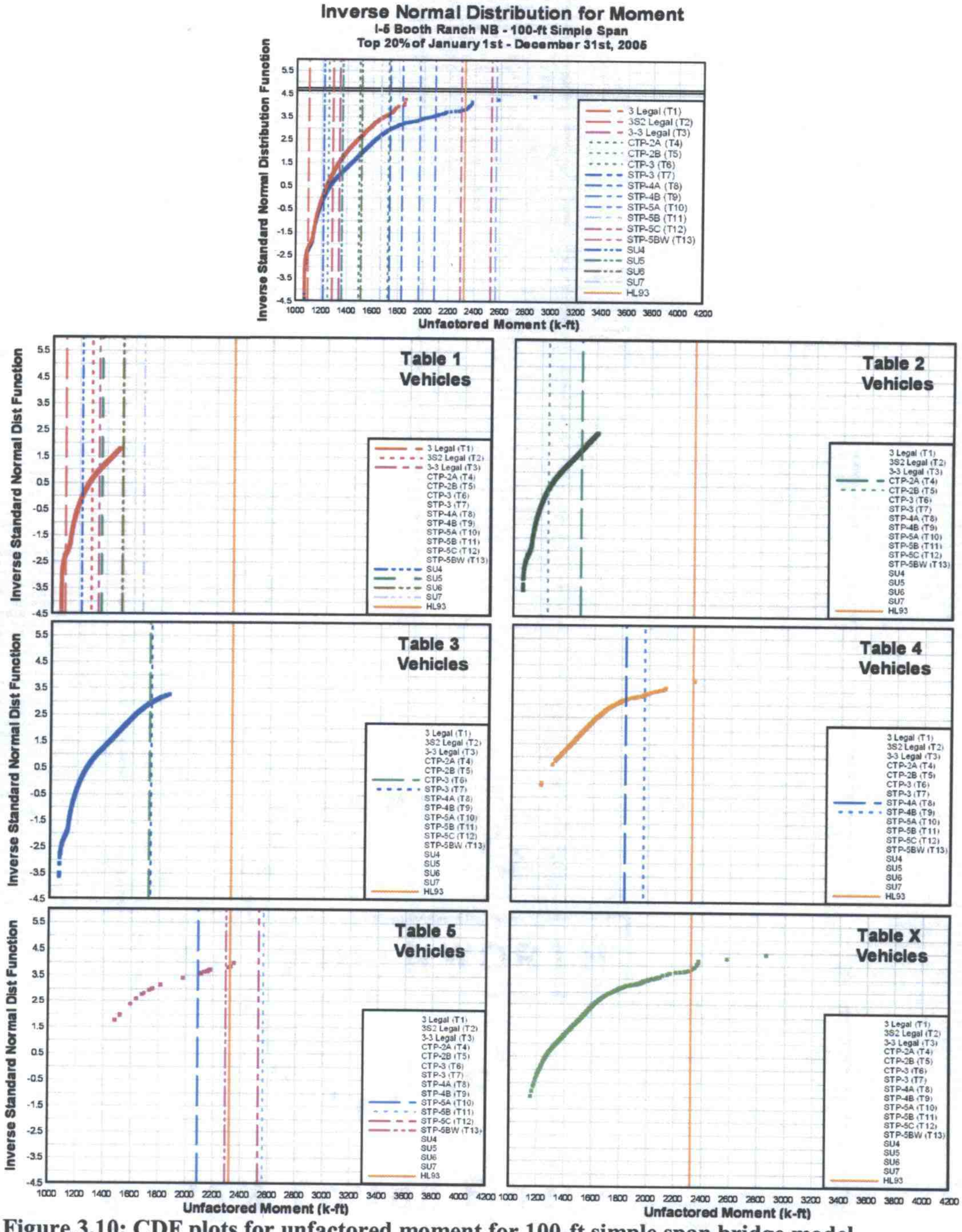

Figure 3.10: CDF plots for unfactored moment for 100-ft simple span bridge model.

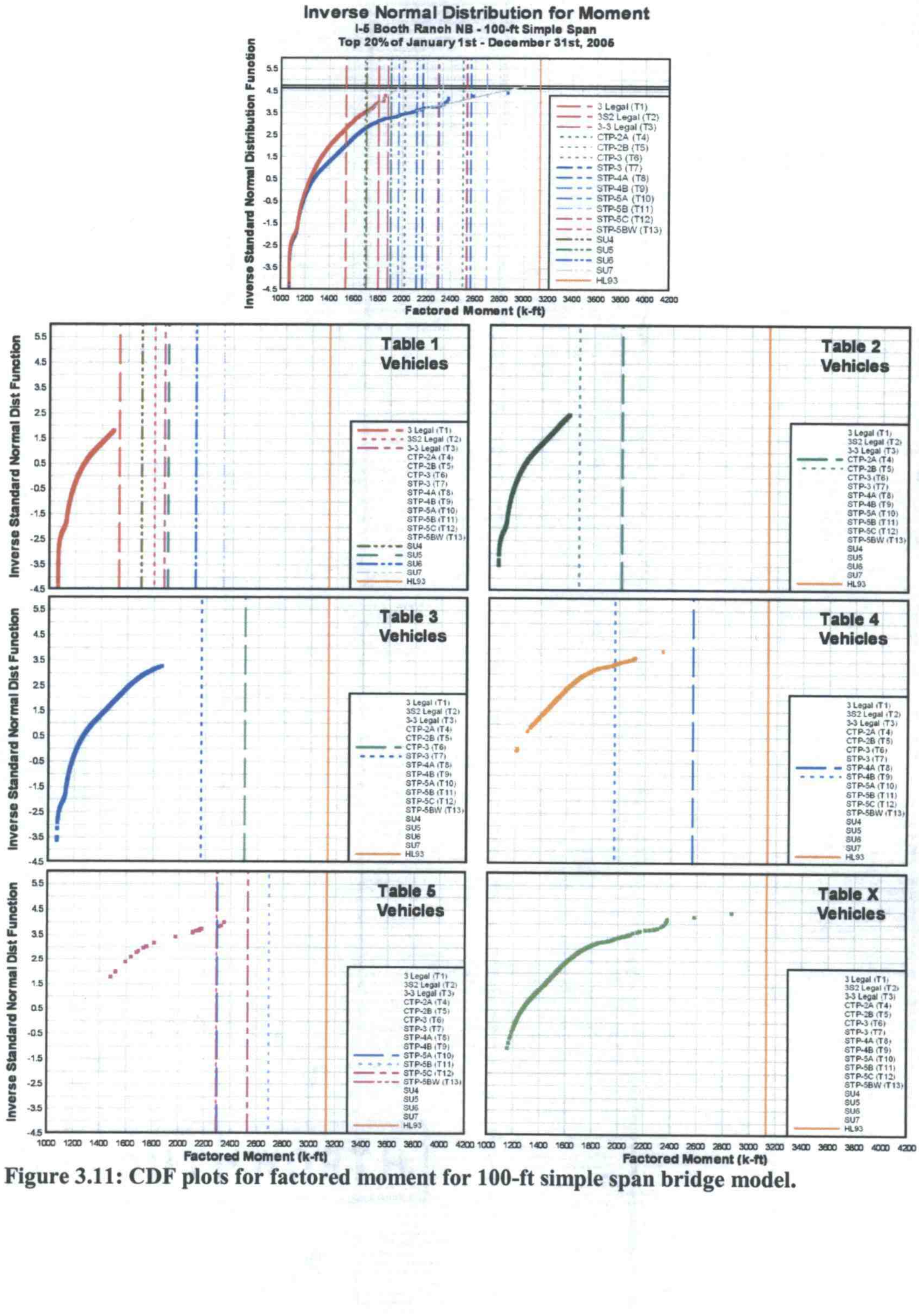

Figure 3.11: CDF plots for factored moment for 100-ft simple span bridge model.

Table 3.1: Current ODOT rating vehicles.

Load Group	Rating Vehicle	OSU Designation	# Axles	Length (ft)	GVW (kips)	Representative of MCTD Weight Table:
Legal Loads	Legal Type 3	T1	3	19	50	1
	Legal Type 3S2	T2	5	51	80	1
	Legal Type 3-3	T3	6	54	80	1
Continuous Trip Permits	OR-CTP-2A	T4	8	82	105.5	2
	OR-CTP-2B	T5	8	75.5	105.5	2
	OR-CTP-3	T6	5	43	98	3
Single Trip Permits	OR-STP-3	T7	6	70	120.5	3
	OR-STP-4A	T8	5	39	99	4
	OR-STP-4B	T9	9	100	185	4
	OR-STP-5A	T10	8	73.5	150.5	5
	OR-STP-5B	T11	8	65	162.5	5
	OR-STP-5C	T12	13	126	258	5
	OR-STP-5BW	T13	9	99	204	5

Table 3.2: Information for I-5 Booth Ranch NB.

Location (MP)	111.07
ADT	12,619
ADTT	3,442
# Lanes	2
# Lanes Instrumented	1
WIM Equipment	Single Load Cell
Date of Last Calibration	Aug 05
Calibration Interval	6 mths. (or as needed)

Table 3.3: Number of axles per vehicle per month.

Month	Number of axles											
	2	3	4	5	6	7	8	9	10	11	12	Total
January	1135	7332	1663	54018	4286	5444	2466	38	15	10	1	76408
February	1216	7474	2003	52280	4267	5498	2490	44	11	9	1	75293
March	1652	7999	3074	60582	4878	6595	2950	53	6	6	1	87796
April	1631	7209	3084	57635	4673	6162	2875	53	15	8	10	83355
May	1714	7450	2499	56393	4519	6262	2545	56	10	14	2	81464
June	1926	8509	2967	58283	4693	6835	2703	63	12	14	1	86006
July	1949	9330	3090	55195	4392	6765	2327	64	10	19	3	83144
August	1730	9562	2698	57125	4572	7155	2726	74	14	18	5	85679
September	1687	8737	2223	54232	4228	6788	2442	78	20	16	2	80453
October	1625	7412	1991	57006	4472	6761	2306	69	16	19	5	81682
November	1342	7094	1739	56237	4241	6281	2230	57	7	12	3	79243
December	1325	6404	1621	58617	4415	6167	2065	66	11	10	2	80703
Total	18932	94512	28652	677603	53636	76713	30125	715	147	155	36	981226

Table 3.4: Comparing sorting methods for table classification at I-5 Booth Ranch NB for 2005.

Month	Sort Method	Table 1	Table 2	Table 3	Table 4	Table 5	Table X	Total #
January	Conventional Sort	69731	2553	3993	70	2	59	76408
	Modified Sort	71370	3701	1331	3	2	1	
February	Conventional Sort	67714	3081	4403	49	2	44	75293
	Modified Sort	70201	4094	992	6	0	0	
March	Conventional Sort	76981	3799	6849	83	0	84	87796
	Modified Sort	80825	5524	1438	7	1	1	
April	Conventional Sort	70033	3463	9564	135	5	155	83355
	Modified Sort	73958	6351	3028	14	2	2	
May	Conventional Sort	71914	3497	5894	87	2	70	81464
	Modified Sort	75156	4991	1310	6	1	0	
June	Conventional Sort	76148	3676	6030	72	1	79	86006
	Modified Sort	79577	5211	1212	6	0	0	
July	Conventional Sort	74208	3338	5462	68	1	67	83144
	Modified Sort	77422	4726	987	6	3	0	
August	Conventional Sort	76208	3909	5414	81	3	64	85679
	Modified Sort	79343	5330	997	7	2	0	
September	Conventional Sort	71884	3801	4681	39	2	46	80453
	Modified Sort	74676	5025	744	6	2	0	
October	Conventional Sort	73326	3590	4648	44	4	70	81682
	Modified Sort	76133	4738	799	10	2	0	
November	Conventional Sort	70988	3373	4760	58	2	62	79243
	Modified Sort	73735	4601	891	14	1	1	
December	Conventional Sort	72429	3204	4942	64	0	64	80703
	Modified Sort	75411	4412	872	6	2	0	

Table 3.5: Maximum projected GVW for varying time windows for I-5 Booth Ranch NB.

Projection Time Window	Maximum Projected GVW (k)												
	2 Days of Data	% Change	7 Days of Data	% Change	14 Days of Data	% Change	30 Days of Data	% Change	60 Days of Data	% Change	120 Days of Data	% Change	1 Year of Data
	June 1st - June 2nd		June 1st - June 7th		June 1st - June 14th		June 1st - June 30th		June 1st - July 30th		June 1st - Sept 28th		June 1st - May 31st
2-Day	179.3												
7-Day	214.7	-16%	179.3										
14-Day	233.8	-14%	200.7	-11%	179.3								
30-Day	253.8	-13%	221.1	-9%	200.9	-11%	179.3						
60-Day	271.3	-12%	238.9	-9%	217.1	-4%	209.0	-7%	193.7				
120-Day	288.2	-11%	256.0	-9%	232.7	-4%	223.5	-4%	214.9	-4%	207.3		
1-Year	314.1	-10%	282.4	-9%	256.6	-4%	245.7	-5%	233.1	-5%	222.5	-7%	207.3
5-Year	349.5	-9%	318.2	-9%	289.3	-5%	276.1	-7%	258.0	-6%	242.8	-8%	223.3

*GVW values are calculated using the equation generated from D-plot's line fit.

Equations From D-Plot (all equations are first order equations).

2-Day	y=1.513+0.009409x	x=(y-1.513)/(0.009409)
7-Day	y=1.772+0.009372x	x=(y-1.772)/(0.009372)
14-Day	y=1.776+0.0103x	x=(y-1.776)/(0.0103)
30-Day	y=1.709+0.01106x	x=(y-1.709)/(0.01106)
60-Day	y=1.274+0.01351x	x=(y-1.274)/(0.01351)
120-Day	y=0.7345+0.01655x	x=(y-0.7345)/(0.01655)
1-Year	y=-0.7155+0.02447x	x=(y+0.7155)/(0.02447)

Table 3.6: Statistical parameters for varying time windows for I-5 Booth Ranch NB.

	Projection Time Window						
	2 Days of Data	7 Days of Data	14 Days of Data	30 Days of Data	60 Days of Data	120 Days of Data	1 Year of Data
	June 1st - June 2nd	June 1st - June 7th	June 1st - June 14th	June 1st - June 30th	June 1st - July 30th	June 1st - Sept 28th	June 1st - May 31st
Number	1392	3857	7753	17202	33831	65531	196246
Mean	81.4	80.8	81.0	81.5	81.1	81.3	81.3
St Dev	10.16	9.63	9.63	9.63	9.54	9.63	9.91
COV	12%	12%	12%	12%	12%	12%	12%
y-intercept	1.51	1.77	1.78	1.71	1.27	0.73	-0.72
Slope	0.0094	0.0094	0.0103	0.0111	0.0135	0.0166	0.0245

Table 3.7: Maximum projected GVW for varying time windows for US 97 Klamath Falls NB.

Projection Time Window	Maximum Projected GVW (k)												
	2 Days of Data	% Change	7 Days of Data	% Change	14 Days of Data	% Change	30 Days of Data	% Change	60 Days of Data	% Change	120 Days of Data	% Change	1 Year of Data
	June 1st - June 2nd		June 1st - June 7th		June 1st - June 14th		June 1st - June 30th		June 1st - July 30th		June 1st - Sept 28th		June 1st - May 31st
2-Day	143.7												
7-Day	191.7	-25%	143.7										
14-Day	216.3	-25%	162.8	18%	192.4								
30-Day	242.0	-24%	182.9	24%	226.2	-15%	192.4						
60-Day	264.4	-24%	200.4	24%	248.4	-8%	227.7	-15%	193				
120-Day	285.9	-24%	217.2	24%	269.6	-8%	247.0	-5%	234.7	-15%	199.9		
1-Year	318.7	-24%	242.9	24%	302.0	-8%	276.5	-7%	258.1	-7%	239.3	-16%	199.9
5-Year	363.2	-24%	277.6	25%	345.9	-9%	316.4	-8%	289.8	-8%	265.3	-18%	218.0

*GVW values are calculated using the equation generated from D-plot's line fit.

Equations From D-Plot (all equations are first order equations).

2-Day	y=1.726+0.007843x	x=(y-1.726)/(0.007843)
7-Day	y=1.707+0.01016x	x=(y-1.707)/(0.01016)
14-Day	y=1.742+0.008044x	x=(y-1.742)/(0.008044)
30-Day	y=1.736+0.008835x	x=(y-1.736)/(0.008835)
60-Day	y=1.305+0.01112x	x=(y-1.305)/(0.01112)
120-Day	y=0.9161+0.01359x	x=(y-0.9161)/(0.01359)
1-Year	y=-2.169+0.03052x	x=(y+2.169)/(0.03052)

Table 3.8: Statistical parameters for varying time windows for US 97 Klamath Falls NB.

	Projection Time Window						
	2 Days of Data	7 Days of Data	14 Days of Data	30 Days of Data	60 Days of Data	120 Days of Data	1 Year of Data
	June 1st - June 2nd	June 1st - June 7th	June 1st - June 14th	June 1st - June 30th	June 1st - July 30th	June 1st - Sept 28th	June 1st - May 31st
Number	460	1286	2535	5608	11032	21428	54986
Mean	78.3	77.8	77.8	77.7	77.5	77.7	78.2
St Dev	7.0	6.5	7.7	7.5	7.7	7.7	8.1
COV	9%	8%	10%	10%	10%	10%	10%
y-intercept	1.73	1.71	1.74	1.74	1.31	0.92	-2.17
Slope	0.0078	0.0102	0.0080	0.0088	0.0111	0.0136	0.0305

Table 3.9: Five-year extrapolated load effects for various span types and lengths.

	Span	Actual Load Effect	5-YR Projected Load Effect	Factored HL-93	Ratio
Shear (k) - Simple Span	50-ft	79	83	89	1.08
	100-ft	109	121	124	1.03
	150-ft	134	148	150	1.01
	200-ft	151	164	174	1.06
Moment (k-ft) - Simple Span	50-ft	1019	1180	1107	0.94
	100-ft	2869	3007	3132	1.04
	150-ft	4816	5391	5697	1.06
	200-ft	7332	8112	8801	1.08
Cont Span	Shear - 50-ft	91	102	101	0.99
	Neg Moment - 50-ft	744	813	702	0.86

Inverse Standard Normal Distribution Function

	Days	# Vehicles	Probability	Inv Nor
All	365	196247	5.096E-06	4.413
	1825	981235	1.019E-06	**4.750**
3S2	365	111314	8.984E-06	4.289
	1825	556570	1.797E-06	**4.634**

Table 3.10: Comparison of shear effects between rating and WIM vehicles.

	Type	γ_L	50-ft Span					100-ft Span					150-ft Span					200-ft Span				
			V	γ_L x V	WIM V	Ratio	%3S2	V	γ_L x V	WIM V	Ratio	%3S2	V	γ_L x V	WIM V	Ratio	%3S2	V	γ_L x V	WIM V	Ratio	%3S2
Tab 1	3 Legal	1.40	38.6	54.0	44.1	1.22	26%	44.2	61.9	59.6	1.04	4%	46.2	64.7	66.3	0.98	-2%	47.1	66.0	69.6	0.95	-5%
	3S2 Legal	1.40	37.5	52.5	44.1	1.19	22%	56.7	79.4	59.6	1.33	35%	64.4	90.2	66.3	1.36	37%	68.4	95.7	69.6	1.37	38%
	3-3 Legal	1.40	37.2	52.0	44.1	1.18	21%	57.6	80.6	59.6	1.35	37%	65.0	91.0	66.3	1.37	38%	68.8	96.3	69.6	1.38	39%
Tab 2	CTP-2A	1.35	39.7	53.5	44.0	1.22	25%	60.9	82.1	67.8	1.21	25%	75.3	101.7	80.2	1.27	33%	82.5	111.3	86.5	1.29	36%
	CTP-2B	1.35	39.0	52.7	44.0	1.20	23%	63.2	85.4	67.8	1.26	31%	75.8	102.4	80.2	1.28	34%	82.0	110.8	86.5	1.28	36%
Tab 3	CTP-3	1.45	51.1	74.1	54.7	1.36	52%	73.5	106.5	83.5	1.28	41%	81.0	117.4	107.1	1.10	16%	84.7	122.8	120.7	1.02	3%
	STP-3	1.25	46.2	57.7	54.7	1.06	8%	76.1	95.1	83.5	1.14	20%	90.1	112.6	107.1	1.05	9%	96.9	121.2	120.7	1.00	1%
Tab 4	STP-4A	1.40	55.8	78.1	64.0	1.22	38%	76.3	106.8	94.3	1.13	22%	83.2	116.5	124.5	0.94	-12%	86.6	121.3	140.8	0.86	-29%
	STP-4B	1.00	60.4	60.4	64.0	0.94	-10%	93.1	93.1	94.3	0.99	-2%	122.3	122.3	124.5	0.98	-3%	137.0	137.0	140.8	0.97	-6%
Tab 5	STP-5A	1.10	54.8	60.3	66.3	0.91	-16%	91.7	100.8	99.6	1.01	2%	109.5	120.4	133.8	0.90	-21%	118.9	130.8	152.1	0.86	-31%
	STP-5B	1.05	62.9	66.0	66.3	0.99	-1%	105.7	111.0	99.6	1.11	20%	123.4	129.6	133.8	0.97	-7%	132.2	138.8	152.1	0.91	-19%
	STP-5C	1.00	69.0	69.0	66.3	1.04	7%	103.6	103.6	99.6	1.04	7%	144.6	144.6	133.8	1.08	17%	172.9	172.9	152.1	1.14	30%
	STP-5BW	1.00	66.9	66.9	66.3	1.01	1%	106.4	106.4	99.6	1.07	12%	138.8	138.8	133.8	1.04	8%	155.1	155.1	152.1	1.02	4%
Tab x	HL93	1.35	66.2	89.4	78.9	1.13	28%	91.8	124.0	109.4	1.13	26%	111.0	149.9	134.3	1.12	24%	128.6	173.6	151.1	1.15	33%
NRL Vehicles	SU4	1.40	42.7	59.7	44.1	1.35	42%	48.3	67.6	59.6	1.14	14%	50.2	70.3	66.3	1.06	6%	51.2	71.6	69.6	1.03	3%
	SU5	1.40	47.2	66.0	44.1	1.50	59%	54.6	76.4	59.6	1.28	30%	57.0	79.8	66.3	1.20	21%	58.3	81.6	69.6	1.17	18%
	SU6	1.40	49.1	68.8	44.1	1.56	66%	59.1	82.7	59.6	1.39	41%	62.3	87.3	66.3	1.32	33%	64.0	89.6	69.6	1.29	29%
	SU7	1.40	51.0	71.4	44.1	1.62	73%	63.9	89.5	59.6	1.50	53%	68.3	95.6	66.3	1.44	46%	70.5	98.7	69.6	1.42	42%

Table 3.11: Comparison of moment effects between rating and WIM vehicles.

	Type	γ_L	50-ft Span					100-ft Span					150-ft Span					200-ft Span				
			M	γ_L x M	WIM M	Ratio	%3S2	M	γ_L x M	WIM M	Ratio	%3S2	M	γ_L x M	WIM M	Ratio	%3S2	M	γ_L x M	WIM M	Ratio	%3S2
Tab 1	3 Legal	1.40	471	659	544	1.21	24%	1096	1534	1493	1.03	3%	1721	2409	2491	0.97	-4%	2345	3283	3489	0.94	-6%
	3S2 Legal	1.40	481	673	544	1.24	27%	1286	1801	1493	1.21	24%	2286	3201	2491	1.29	31%	3287	4601	3489	1.32	34%
	3-3 Legal	1.40	394	551	544	1.01	2%	1340	1876	1493	1.26	30%	2339	3275	2491	1.31	34%	3340	4676	3489	1.34	36%
Tab 2	CTP-2A	1.35	491	663	567	1.17	20%	1494	2017	1617	1.25	31%	2790	3766	2910	1.29	37%	4090	5521	4226	1.31	39%
	CTP-2B	1.35	504	680	567	1.20	23%	1250	1688	1617	1.04	6%	2513	3393	2910	1.17	21%	3775	5097	4226	1.21	26%
Tab 3	CTP-3	1.45	567	822	659	1.25	34%	1722	2497	1866	1.34	49%	2922	4237	3718	1.14	23%	4122	5976	5723	1.04	8%
	STP-3	1.25	588	735	659	1.12	16%	1732	2166	1866	1.16	23%	3207	4009	3718	1.08	13%	4682	5853	5723	1.02	4%
Tab 4	STP-4A	1.40	617	864	749	1.15	24%	1829	2561	2337	1.10	17%	3042	4259	4279	1.00	-1%	4254	5956	6536	0.91	-18%
	STP-4B	1.00	698	698	749	0.93	-11%	1966	1966	2337	0.84	-29%	4055	4055	4279	0.95	-10%	6318	6318	6536	0.97	-7%
Tab 5	STP-5A	1.10	742	817	828	0.99	-2%	2088	2296	2355	0.98	-5%	3938	4331	4776	0.91	-19%	5788	6366	7197	0.88	-25%
	STP-5B	1.05	766	805	828	0.97	-5%	2565	2693	2355	1.14	26%	4552	4779	4776	1.00	0%	6540	6867	7197	0.95	-10%
	STP-5C	1.00	806	806	828	0.97	-5%	2530	2530	2355	1.07	14%	4645	4645	4776	0.97	-6%	7795	7795	7197	1.08	18%
	STP-5BW	1.00	773	773	828	0.93	-11%	2292	2292	2355	0.97	-5%	4691	4691	4776	0.98	-4%	7241	7241	7197	1.01	1%
Tab x	HL93	1.35	820	1107	1019	1.09	18%	2320	3132	2869	1.09	20%	4220	5697	4816	1.18	39%	6520	8801	7332	1.20	45%
NRL Vehicles	SU4	1.40	541	757	544	1.39	44%	1216	1702	1493	1.14	16%	1891	2647	2491	1.06	7%	2565	3592	3489	1.03	3%
	SU5	1.40	585	819	544	1.51	57%	1360	1904	1493	1.28	32%	2135	2989	2491	1.20	22%	2910	4074	3489	1.17	18%
	SU6	1.40	649	909	544	1.67	76%	1512	2117	1493	1.42	49%	2374	3324	2491	1.33	36%	3236	4531	3489	1.30	32%
	SU7	1.40	701	982	544	1.81	91%	1664	2329	1493	1.56	65%	2626	3677	2491	1.48	52%	3588	5024	3489	1.44	47%

Table 3.12: Comparison of 2-span continuous load effects between rating and WIM vehicles.

	Type	γ_L	2-Span Continuous - 50-ft Spans									
			M	γ_L x M	WIM M	Ratio	%3S2	V	γ_L x V	WIM V	Ratio	%3S2
Tab 1	3 Legal	1.40	214	300	367	0.82	-18%	38.2	53.5	48.0	1.12	15%
	3S2 Legal	1.40	371	519	367	1.41	41%	38.0	53.2	48.0	1.11	14%
	3-3 Legal	1.40	315	442	367	1.20	20%	39.5	55.3	48.0	1.15	19%
Tab 2	CTP-2A	1.35	415	560	460	1.22	27%	49.5	66.8	50.4	1.32	43%
	CTP-2B	1.35	432	583	460	1.27	33%	43.9	59.3	50.4	1.18	23%
Tab 3	CTP-3	1.45	415	602	575	1.05	7%	56.1	81.3	60.1	1.35	56%
	STP-3	1.25	505	631	575	1.10	15%	56.3	70.4	60.1	1.17	27%
Tab 4	STP-4A	1.40	395	553	659	0.84	-29%	59.9	83.8	70.7	1.19	35%
	STP-4B	1.00	628	628	659	0.95	-8%	67.5	67.5	70.7	0.96	-8%
Tab 5	STP-5A	1.10	648	713	689	1.04	7%	69.1	76.0	74.6	1.02	4%
	STP-5B	1.05	623	655	689	0.95	-9%	79.2	83.1	74.6	1.11	22%
	STP-5C	1.00	585	585	689	0.85	-28%	79.0	79.0	74.6	1.06	12%
	STP-5BW	1.00	720	720	689	1.05	8%	74.8	74.8	74.6	1.00	1%
Tab x	HL93	1.35	520	702	744	0.94	-11%	75.0	101.3	90.5	1.12	28%
NRL Vehicles	SU4	1.40	240	337	367	0.92	-8%	41.5	58.1	48.0	1.21	27%
	SU5	1.40	268	375	367	1.02	2%	44.6	62.4	48.0	1.30	38%
	SU6	1.40	296	414	367	1.13	13%	48.2	67.5	48.0	1.41	51%
	SU7	1.40	322	451	367	1.23	23%	53.2	74.5	48.0	1.55	70%

Table 3.13: Factored rating vehicle sufficiency.

	Type	50-ft Span		100-ft Span		150-ft Span		200-ft Span		2-Span Cont - 50-ft	
		$\gamma_L V$	$\gamma_L M$	$\gamma_L V$	$\gamma_L M$	$\gamma_L V$	$\gamma_L M$	$\gamma_L V$	$\gamma_L M$	$\gamma_L V$	$\gamma_L M$
Tab 1	3 Legal	1.22	1.21	1.04	1.03	0.98	0.97	0.95	0.94	1.12	0.82
	3S2 Legal	1.19	1.24	1.33	1.21	1.36	1.29	1.37	1.32	1.11	1.41
	3-3 Legal	1.18	1.01	1.35	1.26	1.37	1.31	1.38	1.34	1.15	1.20
Tab 2	CTP-2A	1.22	1.17	1.21	1.25	1.27	1.29	1.29	1.31	1.32	1.22
	CTP-2B	1.20	1.20	1.26	1.04	1.28	1.17	1.28	1.21	1.18	1.27
Tab 3	CTP-3	1.36	1.25	1.28	1.34	1.10	1.14	1.02	1.04	1.35	1.05
	STP-3	1.06	1.12	1.14	1.16	1.05	1.08	1.00	1.02	1.17	1.10
Tab 4	STP-4A	1.22	1.15	1.13	1.10	0.94	1.00	0.86	0.91	1.19	0.84
	STP-4B	0.94	0.93	0.99	0.84	0.98	0.95	0.97	0.97	0.96	0.95
Tab 5	STP-5A	0.91	0.99	1.01	0.98	0.90	0.91	0.86	0.88	1.02	1.04
	STP-5B	0.99	0.97	1.11	1.14	0.97	1.00	0.91	0.95	1.11	0.95
	STP-5C	1.04	0.97	1.04	1.07	1.08	0.97	1.14	1.08	1.06	0.85
	STP-5BW	1.01	0.93	1.07	0.97	1.04	0.98	1.02	1.01	1.00	1.05
Tab x	HL93	1.13	1.09	1.13	1.09	1.12	1.18	1.15	1.20	1.12	0.94
NRL Vehicles	SU4	1.35	1.39	1.14	1.14	1.06	1.06	1.03	1.03	1.21	0.92
	SU5	1.50	1.51	1.28	1.28	1.20	1.20	1.17	1.17	1.30	1.02
	SU6	1.56	1.67	1.39	1.42	1.32	1.33	1.29	1.30	1.41	1.13
	SU7	1.62	1.81	1.50	1.56	1.44	1.48	1.42	1.44	1.55	1.23

Shaded boxes depict ratios less than 1.

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APPENDIX A

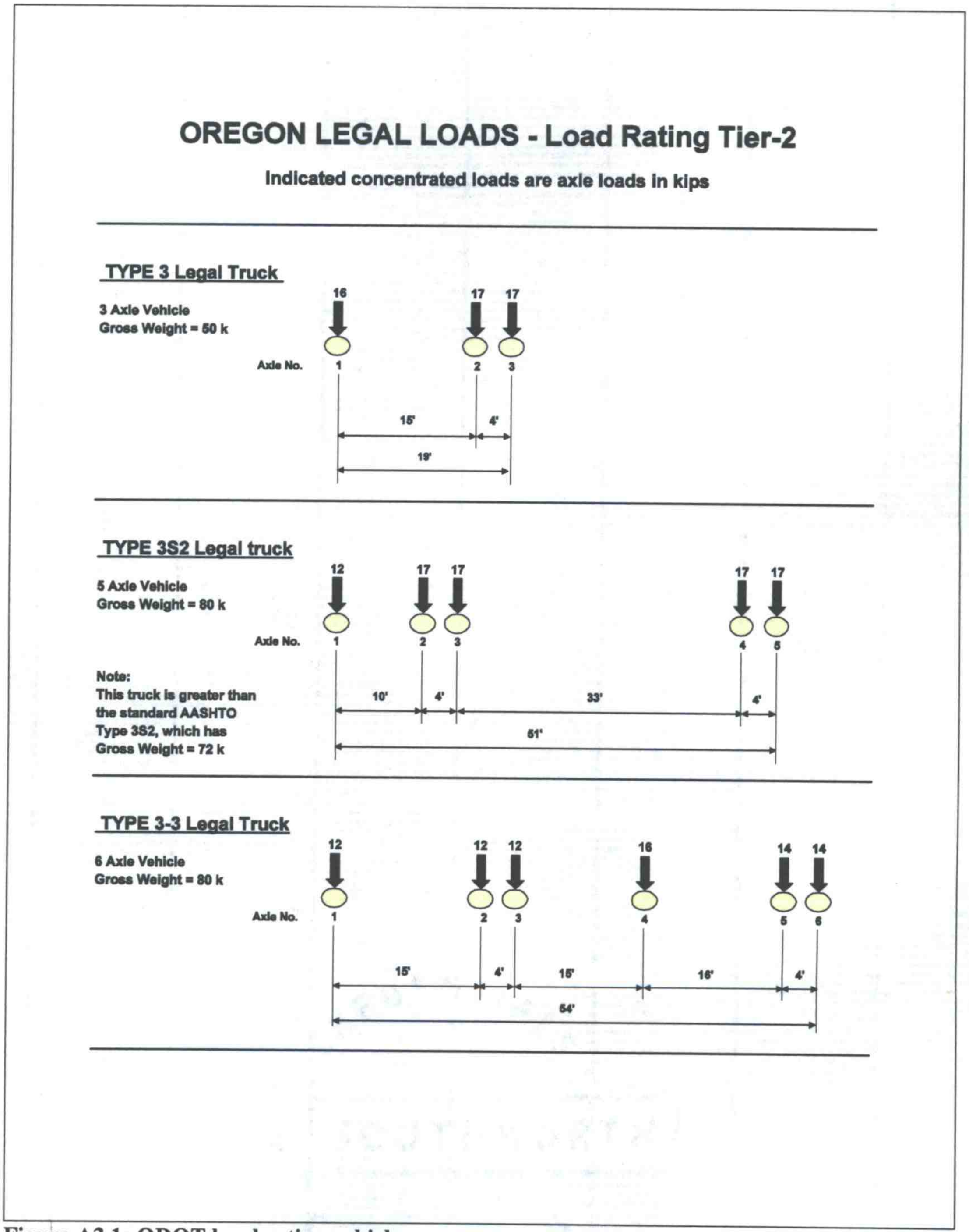


Figure A3.1: ODOT legal rating vehicles.

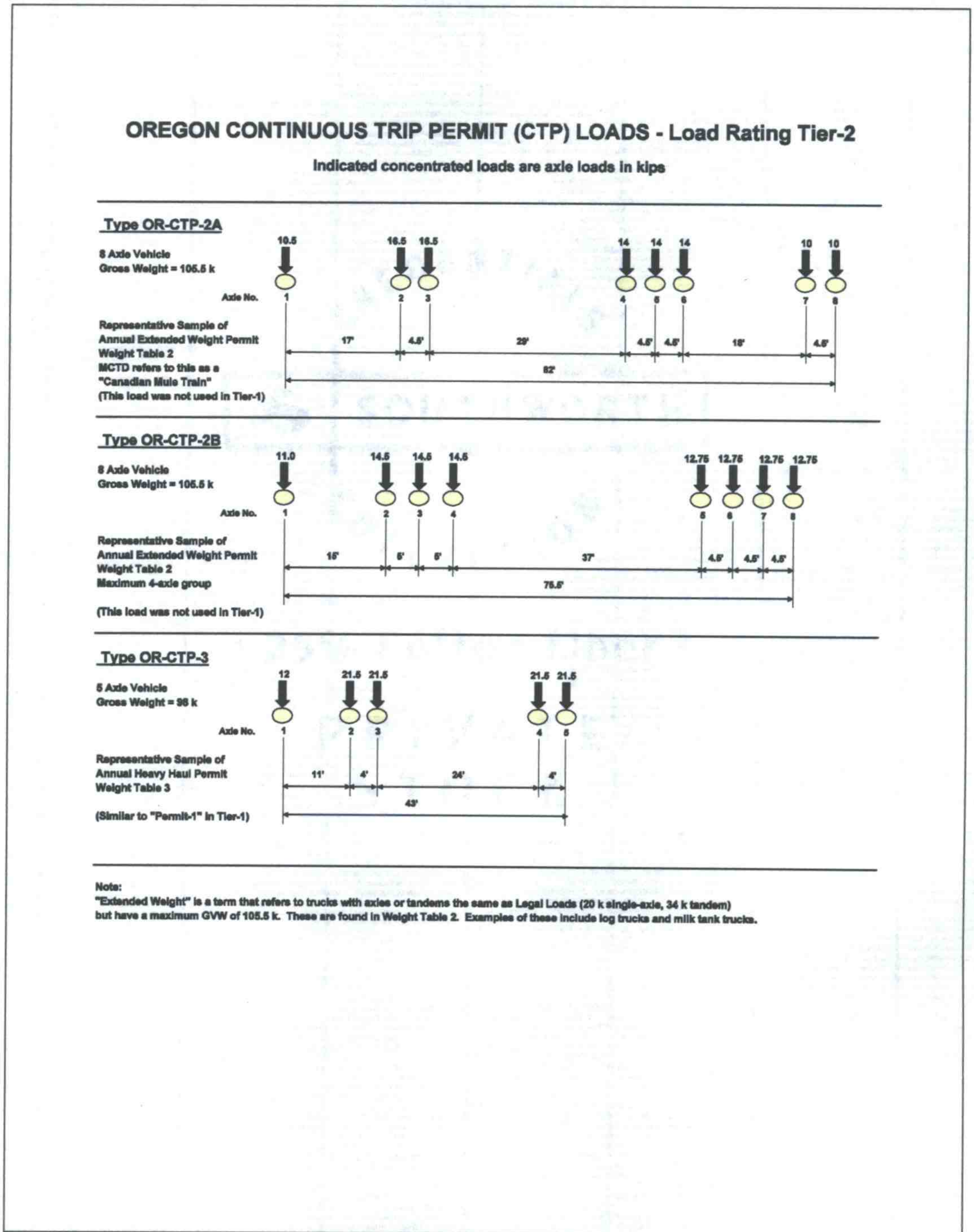


Figure A3.2: ODOT continuous trip permit rating vehicles.

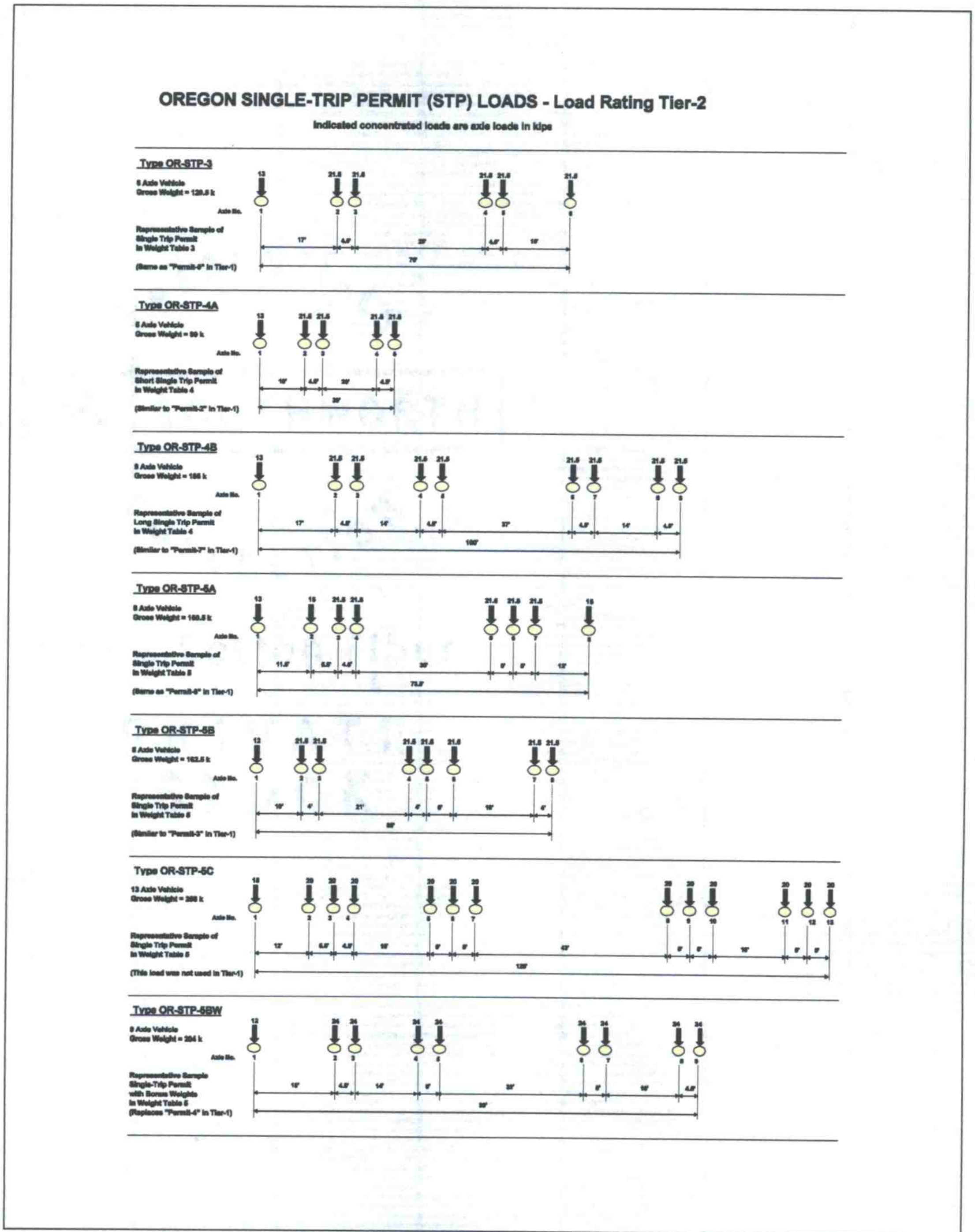


Figure A3.3: ODOT single trip permit rating vehicles.

OREGON LOAD RATING TRUCKS - Load Rating Tier-2

LOAD GROUP	TIER-2 LOAD DESIGNATION	TYPE OF LOAD	G.V.W.	MCTD WEIGHT TABLE	NOTES	Corresponding Tier-1 Truck Designation	Corresponding OSU Study Designation
Design Loads	—	Design Load	72 k	—	Required for NBI reporting in the past, not used in Tier-2.	HS-20	Vehicle 1
	HL-93 Truck	Design Load	72 k	—	The most critical of the three HL-93 combination loads (below) will now be used for NBI reporting. Not used in Tier-1.	—	—
	HL-93 Tandem	Design Load	60 k	—		—	—
	HL-93 Truck + Lane	Design Load Combination (required by LRFR)	—	—	HL-93 Truck applied with 0.640 k/ft lane	—	—
	HL-93 Tandem + Lane	Design Load Combination (required by LRFR)	—	—	HL-93 Tandem applied with 0.640 k/ft lane	—	—
	HL-93 Truck Train + Lane	Design Load Combination (required by LRFR)	—	—	Train of 2 HL-93 Trucks @ 90% applied with 0.640 k/ft lane @ 90%	—	—
Legal Loads	Type 3	Legal Load	60 k	Weight Table 1	Same as AASHTO Legal Type 3	Type 3	Vehicle 2
	Type 3S2	Legal Load	80 k	Weight Table 1	Different than standard AASHTO 3S2, which is 72 k.	Type 3S2	Vehicle 3
	Type 3-3	Legal Load	80 k	Weight Table 1	Same as AASHTO Legal Type 3-3	Type 3-3	Vehicle 4
	Type 3-3 Train + Legal Lane	Legal Load Combination (required by LRFR)	—	—	Train of 2 Legal Type 3-3's @ 75% applied with 0.2 k/ft lane load. Not used in Tier-1.	—	—
	Type 3-3 + Legal Lane	Legal Load Combination (required by LRFR)	—	—	Legal Type 3-3 @ 75% applied with 0.2 k/ft lane load. Used only for Spans > 200 ft. Not used in Tier-1.	—	—
Continuous Trip Permit Loads	Type CTP-2A	Annual Extended Weight Permit	105.5 k	Weight Table 2	MCTD refers to this as a "Canadian Mule Train"	(Permit 8)	—
	Type CTP-2B	Annual Extended Weight Permit	105.5 k	Weight Table 2	Contains maximum allowable 4-axle cluster	(Permit 9)	—
	Type CTP-3	Annual Heavy Haul Permit	98 k	Weight Table 3	Heavy Haul that maximizes Weight Table 3	Permit 1	Vehicle 5
Single Trip Permit Loads	Type STP-3	Single Trip Permit	120.5 k	Weight Table 3	In Tier-1, was used for Local Agency bridges only	Permit 5	Vehicle 9
	Type STP-4A	Single Trip Permit	99 k	Weight Table 4	In Tier-1, was considered representative of CTP's	Permit 2	Vehicle 6
	Type STP-4B	Single Trip Permit	185 k	Weight Table 4	In Tier-1, was used for Local Agency bridges only	Permit 7	Vehicle 11
	Type STP-5A	Single Trip Permit	150.5 k	Weight Table 5	In Tier-1, was used for Local Agency bridges only	Permit 6	Vehicle 10
	Type STP-5B	Single Trip Permit	162.5 k	Weight Table 5	In Tier-1, was considered representative of Weight Table 4	Permit 3	Vehicle 7
	Type STP-5C	Single Trip Permit	258 k	Weight Table 5	Represents upper range of WT-5, heavy 6-axle group in 38 ft	—	—
	Type STP-5BW	Single Trip Permit	204 k	Weight Table 5 with Bonus Weights	In Tier-1, was considered representative of Weight Table 5	Permit 4	Vehicle 8

Shading indicates the loadings to be investigated and reported for ODOT Tier-2 load ratings. The "Type 3-3 + Legal Lane" loading applies only to spans > 200 ft.

LIVELOAD LEVELS OF SERVICE - Load Rating Tier-2

TYPE OF LOAD	Max. G.V.W.	WEIGHT TABLE	REPRESENTATIVE RATING TRUCKS
Oregon Legal Loads	80 k	Table 1	Types 3, 3S2, 3-3
Annual (Continuous Trip) Extended Weight Permit	105.5 k	Table 2	Types CTP-2A, CTP-2B
Annual (Continuous Trip) Heavy Haul Permit	98 k	Table 3	Type CTP-3
Single Trip Permits	228 k	Table 3	Type STP-3
	265 k	Table 4	Types STP-4A and STP-4B
	304 k	Table 5	Types STP-5A, STP-5B, STP-5C, STP-5BW
Super-Loads (require specific evaluation)		Beyond Table 5	—

Figure A3.4: ODOT load rating vehicle descriptions.

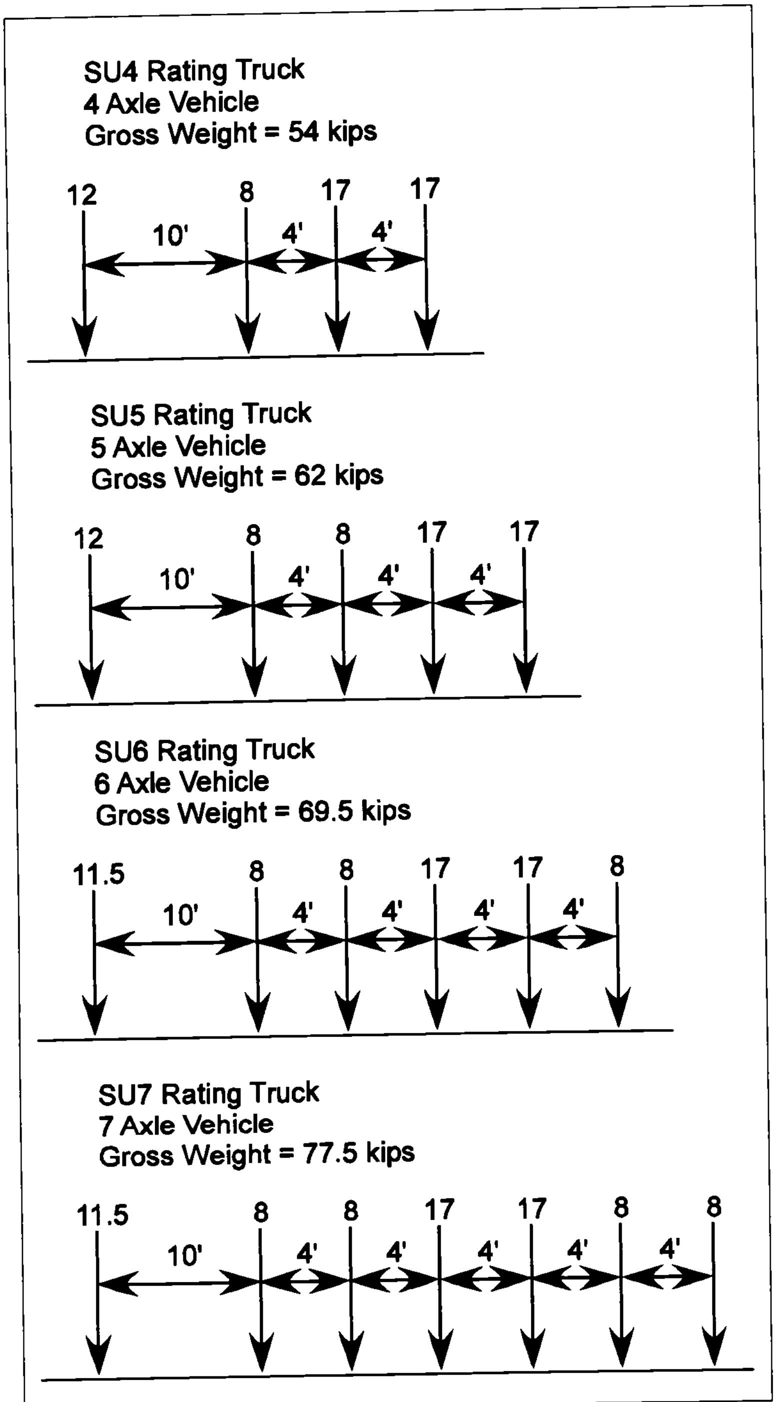


Figure A3.5: AASHTO notional rating loads (specialized hauling vehicles).

OREGON DEPARTMENT OF TRANSPORTATION
MOTOR CARRIER TRANSPORTATION DIVISION
TRANSPORTATION PERMIT UNIT
550 CAPITOL ST NE
SALEM OREGON 97301-2530

Permit Weight Table 1

The following exceptions apply to the table of weights shown below:

Exception 1: Two consecutive tandem axles may weigh up to 34,000 pounds each if:

Minimum Axle Spacing Required	Interstate Highways	Non-Interstate Highways
30 feet or more	Permit Required	No Permit Required
36 feet or more	No Permit Required	No Permit Required

Exception 2: A group of four axles consisting of a set of tandem axles and two axles spaced nine feet or more apart may have a loaded weight of more than 65,500 pounds and up to 70,000 pounds if:

Minimum Axle Spacing Required	Interstate Highways	Non-Interstate Highways
35 feet or more	Permit Required	No Permit Required

- Minimum axle spacing is the distance between the first and last axle of any group shown above.

Wheelbase In Feet*	Number of Axles: 2	3	4	5	6	7 Or More
4	34,000	34,000	34,000	34,000	34,000	34,000
5	34,000	34,000	34,000	34,000	34,000	34,000
6	34,000	34,000	34,000	34,000	34,000	34,000
7	34,000	34,000	34,000	34,000	34,000	34,000
8 & less	34,000	34,000	34,000	34,000	34,000	34,000
Over 8	38,000	42,000	42,000	42,000	42,000	42,000
9	39,000	42,500	42,500	42,500	42,500	42,500
10	40,000	43,500	43,500	43,500	43,500	43,500
11	40,000	44,000	44,000	44,000	44,000	44,000
12	40,000	45,000	50,000	50,000	50,000	50,000
13	40,000	45,500	50,500	50,500	50,500	50,500
14	40,000	46,500	51,500	51,500	51,500	51,500
15	40,000	47,000	52,000	52,000	52,000	52,000
16	40,000	48,000	52,500	58,000	58,000	58,000
17	40,000	48,500	53,500	58,500	58,500	58,500
18	40,000	49,500	54,000	59,000	59,000	59,000
19	40,000	50,000	54,500	60,000	60,000	60,000
20	40,000	51,000	55,500	60,500	66,000	66,000
21	40,000	51,500	56,000	61,000	66,500	66,500
22	40,000	52,500	56,500	61,500	67,000	67,000
23	40,000	53,000	57,500	62,500	68,000	68,000
24	40,000	54,000	58,000	63,000	68,500	74,000
25	40,000	54,500	58,500	63,500	69,000	74,500
26	40,000	55,500	59,500	64,000	69,500	75,000
27	40,000	56,000	60,000	65,000	70,000	75,500
28	40,000	57,000	60,500	65,500	71,000	76,500
29	40,000	57,500	61,500	66,000	71,500	77,000
30	40,000	58,500	62,000	66,500	72,000	77,500
31	40,000	59,000	62,500	67,500	72,500	78,000
32	40,000	60,000	63,500	68,000	73,000	78,500
33	40,000	60,000	64,000	68,500	74,000	79,000
34	40,000	60,000	64,500	69,000	74,500	80,000
35	40,000	60,000	65,500	70,000	75,000	80,000
36	40,000	60,000	66,000	70,500	75,500	80,000
37	40,000	60,000	66,500	71,000	76,000	80,000
38	40,000	60,000	67,500	71,500	77,000	80,000
39	40,000	60,000	68,000	72,500	77,500	80,000
40	40,000	60,000	68,500	73,000	78,000	80,000
41	40,000	60,000	69,500	73,500	78,500	80,000
42	40,000	60,000	70,000	74,000	79,000	80,000
43	40,000	60,000	70,500	75,000	80,000	80,000
44	40,000	60,000	71,500	75,500	80,000	80,000
45	40,000	60,000	72,000	76,000	80,000	80,000
46	40,000	60,000	72,500	76,500	80,000	80,000
47	40,000	60,000	73,500	77,500	80,000	80,000
48	40,000	60,000	74,000	78,000	80,000	80,000
49	40,000	60,000	74,500	78,500	80,000	80,000
50	40,000	60,000	75,500	79,000	80,000	80,000
51	40,000	60,000	76,000	80,000	80,000	80,000
52	40,000	60,000	76,500	80,000	80,000	80,000
53	40,000	60,000	77,500	80,000	80,000	80,000
54	40,000	60,000	78,000	80,000	80,000	80,000
55	40,000	60,000	78,500	80,000	80,000	80,000
56	40,000	60,000	79,500	80,000	80,000	80,000
57 or more	40,000	60,000	80,000	80,000	80,000	80,000

The loaded weight of any group of axles, vehicle, or combination of vehicles shall not exceed that specified in the table of weights shown above or any of the following:

- The manufacturer's side wall tire rating but not to exceed 600 pounds per inch of tire width.
- 600 pounds per inch of tire width.
- 20,000 pounds on any one axle, including any one axle of a group of axles.
- 34,000 pounds on any tandem axle.
- The sum of the permittable axle, tandem axle, or group of axle weights shown above, whichever is less.

Note exceptions 1 and 2 above.

735-6110 (6-02) *Distance measured to the nearest foot; when exactly 1/2 foot or more, round up to the next larger number.* STK# 300557

Figure A3.6: Permit Weight Table 1 [Oregon Motor Carrier].

OREGON DEPARTMENT OF TRANSPORTATION
MOTOR CARRIER TRANSPORTATION DIVISION
550 CAPITOL ST NE
SALEM OR 97301-2530

PERMIT WEIGHT TABLE 2

WHEELBASE	5 Axles	6 Axles	7 Axles	8 or More Axles
47	77500	81000	81000	81000
48	78000	82000	82000	82000
49	78500	83000	83000	83000
50	79000	84000	84000	84000
51	80000	84500	85000	85000
52	80500	85000	86000	86000
53	81000	86000	87000	87000
54	81500	86500	88000	91000
55	82500	87000	89000	92000
56	83000	87500	90000	93000
57	83500	88000	91000	94000
58	84000	89000	92000	95000
59	85000	89500	93000	96000
60	85500	90000	94000	97000
61	86000	90500	95000	98000
62	87000	91000	96000	99000
63	87500	92000	97000	100000
64	88000	92500	97500	101000
65	88500	93000	98000	102000
66	89000	93500	98500	103000
67	90000	94000	99000	104000
68	90000	95000	99500	105000
69	90000	95500	100000	105500
70	90000	96000	101000	105500
71	90000	96500	101500	105500
72	90000	96500	102000	105500
73	90000	96500	102500	105500
74	90000	96500	103000	105500
75	90000	96500	104000	105500
76	90000	96500	104500	105500
77	90000	96500	105000	105500
78	90000	96500	105500	105500

See Weight Table 1, if using less than five axles or 47 feet wheelbase.

735-8111(2-00) • DISTANCE MEASURED TO THE NEAREST FOOT. WHEN EXACTLY 1/2 FOOT OR MORE, ROUND UP TO THE NEXT LARGER NUMBER • STK # 300556

Figure A3.7: Permit Weight Table 2 [Oregon Motor Carrier].

OREGON DEPARTMENT OF TRANSPORTATION
MOTOR CARRIER TRANSPORTATION DIVISION
550 CAPITOL ST NE
SALEM OR 97301-2530

PERMIT WEIGHT TABLE 3

WHEELBASE

	2 Axles	3 Axles	4 Axles	5 Axles	6 Axles	7 Axles	8 Axles	9 Axles	10 Axles	11 Axles	12 Axles	13 Axles	14 Axles	15 Axles	16 Axles	17 Axles	18 Axles	19 Axles	20 Axles
4	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000
5	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000
6	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000
7	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000
8	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000
OVER 8 (BUT LESS THAN 8'6")	43,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000
9	43,000	49,000	49,000	49,000	49,000	49,000	49,000	49,000	49,000	49,000	49,000	49,000	49,000	49,000	49,000	49,000	49,000	49,000	49,000
10	43,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
11	43,000	51,000	51,000	51,000	51,000	51,000	51,000	51,000	51,000	51,000	51,000	51,000	51,000	51,000	51,000	51,000	51,000	51,000	51,000
12	43,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000
13	43,000	53,000	53,000	53,000	53,000	53,000	53,000	53,000	53,000	53,000	53,000	53,000	53,000	53,000	53,000	53,000	53,000	53,000	53,000
14	43,000	54,000	54,000	54,000	54,000	54,000	54,000	54,000	54,000	54,000	54,000	54,000	54,000	54,000	54,000	54,000	54,000	54,000	54,000
15	43,000	55,000	55,000	55,000	55,000	55,000	55,000	55,000	55,000	55,000	55,000	55,000	55,000	55,000	55,000	55,000	55,000	55,000	55,000
16	43,000	56,000	56,000	56,000	56,000	56,000	56,000	56,000	56,000	56,000	56,000	56,000	56,000	56,000	56,000	56,000	56,000	56,000	56,000
17	43,000	57,000	57,000	57,000	57,000	57,000	57,000	57,000	57,000	57,000	57,000	57,000	57,000	57,000	57,000	57,000	57,000	57,000	57,000
18	43,000	58,000	58,000	58,000	58,000	58,000	58,000	58,000	58,000	58,000	58,000	58,000	58,000	58,000	58,000	58,000	58,000	58,000	58,000
19	43,000	64,500	70,800	70,800	70,800	70,800	70,800	70,800	70,800	70,800	70,800	70,800	70,800	70,800	70,800	70,800	70,800	70,800	70,800
20	43,000	64,500	72,000	72,000	72,000	72,000	72,000	72,000	72,000	72,000	72,000	72,000	72,000	72,000	72,000	72,000	72,000	72,000	72,000
21	43,000	64,500	73,200	73,200	73,200	73,200	73,200	73,200	73,200	73,200	73,200	73,200	73,200	73,200	73,200	73,200	73,200	73,200	73,200
22	43,000	64,500	74,400	74,400	74,400	74,400	74,400	74,400	74,400	74,400	74,400	74,400	74,400	74,400	74,400	74,400	74,400	74,400	74,400
23	43,000	64,500	75,600	75,600	75,600	75,600	75,600	75,600	75,600	75,600	75,600	75,600	75,600	75,600	75,600	75,600	75,600	75,600	75,600
24	43,000	64,500	76,800	76,800	76,800	76,800	76,800	76,800	76,800	76,800	76,800	76,800	76,800	76,800	76,800	76,800	76,800	76,800	76,800
25	43,000	64,500	78,000	78,000	78,000	78,000	78,000	78,000	78,000	78,000	78,000	78,000	78,000	78,000	78,000	78,000	78,000	78,000	78,000
26	43,000	64,500	79,200	79,200	79,200	79,200	79,200	79,200	79,200	79,200	79,200	79,200	79,200	79,200	79,200	79,200	79,200	79,200	79,200
27	43,000	64,500	80,400	80,400	80,400	80,400	80,400	80,400	80,400	80,400	80,400	80,400	80,400	80,400	80,400	80,400	80,400	80,400	80,400
28	43,000	64,500	81,600	81,600	81,600	81,600	81,600	81,600	81,600	81,600	81,600	81,600	81,600	81,600	81,600	81,600	81,600	81,600	81,600
29	43,000	64,500	82,800	82,800	82,800	82,800	82,800	82,800	82,800	82,800	82,800	82,800	82,800	82,800	82,800	82,800	82,800	82,800	82,800
30	43,000	64,500	84,000	84,000	84,000	84,000	84,000	84,000	84,000	84,000	84,000	84,000	84,000	84,000	84,000	84,000	84,000	84,000	84,000
31	43,000	64,500	85,200	85,200	85,200	85,200	85,200	85,200	85,200	85,200	85,200	85,200	85,200	85,200	85,200	85,200	85,200	85,200	85,200
32	43,000	64,500	86,000	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400	86,400
33	43,000	64,500	86,000	87,600	87,600	87,600	87,600	87,600	87,600	87,600	87,600	87,600	87,600	87,600	87,600	87,600	87,600	87,600	87,600
34	43,000	64,500	86,000	88,800	88,800	88,800	88,800	88,800	88,800	88,800	88,800	88,800	88,800	88,800	88,800	88,800	88,800	88,800	88,800
35	43,000	64,500	86,000	90,000	90,000	90,000	90,000	90,000	90,000	90,000	90,000	90,000	90,000	90,000	90,000	90,000	90,000	90,000	90,000
36	43,000	64,500	86,000	91,200	91,200	91,200	91,200	91,200	91,200	91,200	91,200	91,200	91,200	91,200	91,200	91,200	91,200	91,200	91,200
37	43,000	64,500	86,000	92,400	92,400	92,400	92,400	92,400	92,400	92,400	92,400	92,400	92,400	92,400	92,400	92,400	92,400	92,400	92,400
38	43,000	64,500	86,000	93,600	93,600	93,600	93,600	93,600	93,600	93,600	93,600	93,600	93,600	93,600	93,600	93,600	93,600	93,600	93,600
39	43,000	64,500	86,000	94,800	94,800	94,800	94,800	94,800	94,800	94,800	94,800	94,800	94,800	94,800	94,800	94,800	94,800	94,800	94,800
40	43,000	64,500	86,000	96,000	96,000	96,000	96,000	96,000	96,000	96,000	96,000	96,000	96,000	96,000	96,000	96,000	96,000	96,000	96,000
41	43,000	64,500	86,000	97,200	97,200	97,200	97,200	97,200	97,200	97,200	97,200	97,200	97,200	97,200	97,200	97,200	97,200	97,200	97,200
42	43,000	64,500	86,000	98,400	98,400	98,400	98,400	98,400	98,400	98,400	98,400	98,400	98,400	98,400	98,400	98,400	98,400	98,400	98,400
43	43,000	64,500	86,000	99,600	99,600	99,600	99,600	99,600	99,600	99,600	99,600	99,600	99,600	99,600	99,600	99,600	99,600	99,600	99,600
44	43,000	64,500	86,000	100,800	100,800	100,800	100,800	100,800	100,800	100,800	100,800	100,800	100,800	100,800	100,800	100,800	100,800	100,800	100,800
45	43,000	64,500	86,000	102,000	102,000	102,000	102,000	102,000	102,000	102,000	102,000	102,000	102,000	102,000	102,000	102,000	102,000	102,000	102,000
46	43,000	64,500	86,000	103,200	103,200	103,200	103,200	103,200	103,200	103,200	103,200	103,200	103,200	103,200	103,200	103,200	103,200	103,200	103,200
47	43,000	64,500	86,000	104,400	104,400	104,400	104,400	104,400	104,400	104,400	104,400	104,400	104,400	104,400	104,400	104,400	104,400	104,400	104,400
48	43,000	64,500	86,000	105,600	105,600	105,600	105,600	105,600	105,600	105,600	105,600	105,600	105,600	105,600	105,600	105,600	105,600	105,600	105,600
49	43,000	64,500	86,000	106,800	106,800	106,800	106,800	106,800	106,800	106,800	106,800	106,800	106,800	106,800	106,800	106,800	106,800	106,800	106,800
50	43,000	64,500	86,000	107,500	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000
51	43,000	64,500	86,000	107,500	109,200	109,200	109,200	109,200	109,200	109,200	109,200	109,200	109,200	109,200	109,200	109,200	109,200	109,200	109,200
52	43,000	64,500	86,000	107,500	110,400	110,400	110,400	110,400	110,400	110,400	110,400	110,400	110,400	110,400	110,400	110,400	110,400	110,400	110,400
53	43,000	64,500	86,000	107,500	111,600	111,600	111,600	111,600	111,600	111,600	111,600	111,600	111,600	111,600	111,600	111,600	111,600	111,600	111,600
54	43,000	64,500	86,000	107,500	112,800	112,800	112,800	112,800	112,800	112,800	112,800	112,800	112,800	112,800	112,800	112,800	112,800	112,800	112,800
55	43,000	64,500	86,000	107,500	114,000	114,000	114,000	114,000	114,000	114,000	114,000	114,000	114,000	114,000	114,000	114,000	114,000	114,000	114,000
56	43,000	64,500	86,000	107,500	115,200	115,200	115,200	115,200	115,200	115,200	115,200	115,200	115,200	115,200	115,200	115,200	115,200	115,200	115,200
57	43,000	64,500	86,000	107,500	116,400	116,400	116,400	116,400	116,400	116,400	116,400	116,400	116,400	116,400	116,400	116,400	116,400	116,400	116,400
58	43,000	64,500	86,000	107,500	117,600	117,600	117,600	117,600	117,600	117,600	117,600	117,600	117,600	117,600	117,600	117,600	117,600	117,600	117,600
59	43,000	64,500	86,000	107,500	118,800	118,800	118,800	118,800	118,800	118,800	118,800	118,800	118,800	118,800	118,800	118,800	118,800	118,800	118,800
60	43,000	64,500	86,000	107,500	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000
61	43,000	64,500	86,000	107,500	121,200	121,200	121,200	121,200	121,200	121,200	121,200	121,200	121,200	121,200	121,200	121,200	121,200	121,200	121,200
62	43,000	64,500	86,000	107,500	122,400	122,400	122,400	122,400	122,400	122,400	122,400	122,400	122,400	122,400	122,400	122,400	122,400	122,400	122,400
63	43,000	64,500	86,000	107,500	123,600	123,600	123,600	123,600	123,600	123,600	123,600	123,600	123,600	123,600	123,600	123,600	123,600	123,600	123,600
64	43,000	64,500	86,000	107,500	124,800	124,800	124,800	124,800	124,800	124,800	124,800	124,800	124,800	124,800	124,800	124,800	124,800	124,800	124,800
65	43,000	64,500	86,000	107,500	126,000	126,000	126,000	126,000	126,000	126,000	126,000	126,000	126,000	126,000	126,000	126,000	126,000	126,000	126,000
66	43,000	64,500	86,000	107,500	127,200	127,200	127,200	127,200	127,200	127,200	127,200	127,200	127,200	127,200	127,200	127,200	127,200	127,200	127,200
67	43,000	64,500	86,000	107,500	128,400	128,400	128,400	128,400	128,400	128,400	128,400	128,400	128,400	128,400	128,400	128,400	128,400	128,400	128,400
68	43,000	64,500	86,000	107,500	129,000	129,600	129,600	129,600	129,600	129,600	129,600	129,600	129,600	129,600	129,600	129,600	129,600	129,600	129,600
69	43,000	64,500	86,000	107,500	129,000	130,800	130,800	130,800	130,800	130,800	130,800	130,800	130,800	130,800	130,800	130,800	130,800	130,800	130,800
70	43,000	64,500	86,000	107,500	129,000	132,000	132,000	132,000	132,000	132,000	132,000	132,000	132,000	132,000	132,000	132,000	132,000	132,000	132,000

735-8112 (10-99) ● DISTANCE MEASURED TO THE NEAREST FOOT. WHEN EXACTLY 1/2 FOOT OR MORE, ROUND UP TO THE NEXT LARGER NUMBER ● STK # 300559

Figure A3.8: Permit Weight Table 3 [Oregon Motor Carrier].

WHEELBASE	2 Axles	3 Axles	4 Axles	5 Axles	6 Axles	7 Axles	8 Axles	9 Axles	10 Axles	11 Axles	12 Axles	13 Axles	14 Axles	15 Axles	16 Axles	17 Axles	18 Axles	19 Axles	20 Axles
71	43,000	64,500	86,000	107,500	129,000	133,200	133,200	133,200	133,200	133,200	133,200	133,200	133,200	133,200	133,200	133,200	133,200	133,200	133,200
72	43,000	64,500	86,000	107,500	129,000	134,400	134,400	134,400	134,400	134,400	134,400	134,400	134,400	134,400	134,400	134,400	134,400	134,400	134,400
73	43,000	64,500	86,000	107,500	129,000	135,600	135,600	135,600	135,600	135,600	135,600	135,600	135,600	135,600	135,600	135,600	135,600	135,600	135,600
74	43,000	64,500	86,000	107,500	129,000	136,800	136,800	136,800	136,800	136,800	136,800	136,800	136,800	136,800	136,800	136,800	136,800	136,800	136,800
75	43,000	64,500	86,000	107,500	129,000	138,000	138,000	138,000	138,000	138,000	138,000	138,000	138,000	138,000	138,000	138,000	138,000	138,000	138,000
76	43,000	64,500	86,000	107,500	129,000	139,200	139,200	139,200	139,200	139,200	139,200	139,200	139,200	139,200	139,200	139,200	139,200	139,200	139,200
77	43,000	64,500	86,000	107,500	129,000	140,400	140,400	140,400	140,400	140,400	140,400	140,400	140,400	140,400	140,400	140,400	140,400	140,400	140,400
78	43,000	64,500	86,000	107,500	129,000	141,600	141,600	141,600	141,600	141,600	141,600	141,600	141,600	141,600	141,600	141,600	141,600	141,600	141,600
79	43,000	64,500	86,000	107,500	129,000	142,800	142,800	142,800	142,800	142,800	142,800	142,800	142,800	142,800	142,800	142,800	142,800	142,800	142,800
80	43,000	64,500	86,000	107,500	129,000	144,000	144,000	144,000	144,000	144,000	144,000	144,000	144,000	144,000	144,000	144,000	144,000	144,000	144,000
81	43,000	64,500	86,000	107,500	129,000	145,200	145,200	145,200	145,200	145,200	145,200	145,200	145,200	145,200	145,200	145,200	145,200	145,200	145,200
82	43,000	64,500	86,000	107,500	129,000	146,400	146,400	146,400	146,400	146,400	146,400	146,400	146,400	146,400	146,400	146,400	146,400	146,400	146,400
83	43,000	64,500	86,000	107,500	129,000	147,600	147,600	147,600	147,600	147,600	147,600	147,600	147,600	147,600	147,600	147,600	147,600	147,600	147,600
84	43,000	64,500	86,000	107,500	129,000	148,800	148,800	148,800	148,800	148,800	148,800	148,800	148,800	148,800	148,800	148,800	148,800	148,800	148,800
85	43,000	64,500	86,000	107,500	129,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000
86	43,000	64,500	86,000	107,500	129,000	150,500	151,200	151,200	151,200	151,200	151,200	151,200	151,200	151,200	151,200	151,200	151,200	151,200	151,200
87	43,000	64,500	86,000	107,500	129,000	150,500	152,400	152,400	152,400	152,400	152,400	152,400	152,400	152,400	152,400	152,400	152,400	152,400	152,400
88	43,000	64,500	86,000	107,500	129,000	150,500	153,600	153,600	153,600	153,600	153,600	153,600	153,600	153,600	153,600	153,600	153,600	153,600	153,600
89	43,000	64,500	86,000	107,500	129,000	150,500	154,800	154,800	154,800	154,800	154,800	154,800	154,800	154,800	154,800	154,800	154,800	154,800	154,800
90	43,000	64,500	86,000	107,500	129,000	150,500	156,000	156,000	156,000	156,000	156,000	156,000	156,000	156,000	156,000	156,000	156,000	156,000	156,000
91	43,000	64,500	86,000	107,500	129,000	150,500	157,200	157,200	157,200	157,200	157,200	157,200	157,200	157,200	157,200	157,200	157,200	157,200	157,200
92	43,000	64,500	86,000	107,500	129,000	150,500	158,400	158,400	158,400	158,400	158,400	158,400	158,400	158,400	158,400	158,400	158,400	158,400	158,400
93	43,000	64,500	86,000	107,500	129,000	150,500	159,600	159,600	159,600	159,600	159,600	159,600	159,600	159,600	159,600	159,600	159,600	159,600	159,600
94	43,000	64,500	86,000	107,500	129,000	150,500	160,800	160,800	160,800	160,800	160,800	160,800	160,800	160,800	160,800	160,800	160,800	160,800	160,800
95	43,000	64,500	86,000	107,500	129,000	150,500	162,000	162,000	162,000	162,000	162,000	162,000	162,000	162,000	162,000	162,000	162,000	162,000	162,000
96	43,000	64,500	86,000	107,500	129,000	150,500	163,200	163,200	163,200	163,200	163,200	163,200	163,200	163,200	163,200	163,200	163,200	163,200	163,200
97	43,000	64,500	86,000	107,500	129,000	150,500	164,400	164,400	164,400	164,400	164,400	164,400	164,400	164,400	164,400	164,400	164,400	164,400	164,400
98	43,000	64,500	86,000	107,500	129,000	150,500	165,600	165,600	165,600	165,600	165,600	165,600	165,600	165,600	165,600	165,600	165,600	165,600	165,600
99	43,000	64,500	86,000	107,500	129,000	150,500	166,800	166,800	166,800	166,800	166,800	166,800	166,800	166,800	166,800	166,800	166,800	166,800	166,800
100	43,000	64,500	86,000	107,500	129,000	150,500	168,000	168,000	168,000	168,000	168,000	168,000	168,000	168,000	168,000	168,000	168,000	168,000	168,000
101	43,000	64,500	86,000	107,500	129,000	150,500	169,200	169,200	169,200	169,200	169,200	169,200	169,200	169,200	169,200	169,200	169,200	169,200	169,200
102	43,000	64,500	86,000	107,500	129,000	150,500	170,400	170,400	170,400	170,400	170,400	170,400	170,400	170,400	170,400	170,400	170,400	170,400	170,400
103	43,000	64,500	86,000	107,500	129,000	150,500	171,600	171,600	171,600	171,600	171,600	171,600	171,600	171,600	171,600	171,600	171,600	171,600	171,600
104	43,000	64,500	86,000	107,500	129,000	150,500	172,000	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800
105	43,000	64,500	86,000	107,500	129,000	150,500	172,000	174,000	174,000	174,000	174,000	174,000	174,000	174,000	174,000	174,000	174,000	174,000	174,000
106	43,000	64,500	86,000	107,500	129,000	150,500	172,000	175,200	175,200	175,200	175,200	175,200	175,200	175,200	175,200	175,200	175,200	175,200	175,200
107	43,000	64,500	86,000	107,500	129,000	150,500	172,000	176,400	176,400	176,400	176,400	176,400	176,400	176,400	176,400	176,400	176,400	176,400	176,400
108	43,000	64,500	86,000	107,500	129,000	150,500	172,000	177,600	177,600	177,600	177,600	177,600	177,600	177,600	177,600	177,600	177,600	177,600	177,600
109	43,000	64,500	86,000	107,500	129,000	150,500	172,000	178,800	178,800	178,800	178,800	178,800	178,800	178,800	178,800	178,800	178,800	178,800	178,800
110	43,000	64,500	86,000	107,500	129,000	150,500	172,000	180,000	180,000	180,000	180,000	180,000	180,000	180,000	180,000	180,000	180,000	180,000	180,000
111	43,000	64,500	86,000	107,500	129,000	150,500	172,000	181,200	181,200	181,200	181,200	181,200	181,200	181,200	181,200	181,200	181,200	181,200	181,200
112	43,000	64,500	86,000	107,500	129,000	150,500	172,000	182,400	182,400	182,400	182,400	182,400	182,400	182,400	182,400	182,400	182,400	182,400	182,400
113	43,000	64,500	86,000	107,500	129,000	150,500	172,000	183,600	183,600	183,600	183,600	183,600	183,600	183,600	183,600	183,600	183,600	183,600	183,600
114	43,000	64,500	86,000	107,500	129,000	150,500	172,000	184,800	184,800	184,800	184,800	184,800	184,800	184,800	184,800	184,800	184,800	184,800	184,800
115	43,000	64,500	86,000	107,500	129,000	150,500	172,000	186,000	186,000	186,000	186,000	186,000	186,000	186,000	186,000	186,000	186,000	186,000	186,000
116	43,000	64,500	86,000	107,500	129,000	150,500	172,000	187,200	187,200	187,200	187,200	187,200	187,200	187,200	187,200	187,200	187,200	187,200	187,200
117	43,000	64,500	86,000	107,500	129,000	150,500	172,000	188,400	188,400	188,400	188,400	188,400	188,400	188,400	188,400	188,400	188,400	188,400	188,400
118	43,000	64,500	86,000	107,500	129,000	150,500	172,000	189,600	189,600	189,600	189,600	189,600	189,600	189,600	189,600	189,600	189,600	189,600	189,600
119	43,000	64,500	86,000	107,500	129,000	150,500	172,000	190,800	190,800	190,800	190,800	190,800	190,800	190,800	190,800	190,800	190,800	190,800	190,800
120	43,000	64,500	86,000	107,500	129,000	150,500	172,000	192,000	192,000	192,000	192,000	192,000	192,000	192,000	192,000	192,000	192,000	192,000	192,000
121	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,200	193,200	193,200	193,200	193,200	193,200	193,200	193,200	193,200	193,200	193,200	193,200
122	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	194,400	194,400	194,400	194,400	194,400	194,400	194,400	194,400	194,400	194,400	194,400
123	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	195,600	195,600	195,600	195,600	195,600	195,600	195,600	195,600	195,600	195,600	195,600
124	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	196,800	196,800	196,800	196,800	196,800	196,800	196,800	196,800	196,800	196,800	196,800
125	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	198,000	198,000	198,000	198,000	198,000	198,000	198,000	198,000	198,000	198,000	198,000
126	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	199,200	199,200	199,200	199,200	199,200	199,200	199,200	199,200	199,200	199,200	199,200
127	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	200,400	200,400	200,400	200,400	200,400	200,400	200,400	200,400	200,400	200,400	200,400
128	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	201,600	201,600	201,600	201,600	201,600	201,600	201,600	201,600	201,600	201,600	201,600
129	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	202,800	202,800	202,800	202,800	202,800	202,800	202,800	202,800	202,800	202,800	202,800
130	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	204,000	204,000	204,000	204,000	204,000	204,000	204,000	204,000	204,000	204,000	204,000
131	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	205,200	205,200	205,200	205,200	205,200	205,200	205,200	205,200	205,200	205,200	205,200
132	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	206,400	206,400	206,400	206,400	206,400	206,400	206,400	206,400	206,400	206,400	206,400
133	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	207,600	207,600	207,600	207,600	207,600	207,600	207,600	207,600	207,600	207,600	207,600
134	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	208,800	208,800	208,800	208,800	208,800	208,800	208,800	208,800	208,800	208,800	208,800
135	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	210,000	210,000	210,000	210,000	210,000	210,000	210,000	210,000	210,000	210,000	210,000
136	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	211,200	211,200	211,200	211,200	211,200	211,200	211,200	211,200	211,200	211,200	211,200
137	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	212,400	212,400	212,400	212,400	212,400	212,400	212,400	212,400	212,400	212,400	212,400
138	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	213,600	213,600	213,600	213,600	213,600	213,600	213,600	213,600	213,600	213,600	213,600
139	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	214,800	214,800	214,800	214,800	214,800	214,800	214,800	214,800	214,800	214,800	214,800
140	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000
141	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	217,200	217,200	217,200	217,200	217,200	217,200	217,200	217,200	217,200	217,200
142	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	218,400	218,400	218,400	218,400	218,400	218,400	218,400	218,400	218,400	218,400
143	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	219,600	219,600	219,600	219,600	219,600	219,600	219,600	219,600	219,600	219,600
144	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	220,800	220,800	220,800	220,800	220,800	220,800	220,800	220,800	220,800	220,800
145	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	222,000	222,000	222,000	222,000	222,000	222,000	222,000	222,000	222,000	222,000
146	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	223,200	223,200	223,200	223,200	223,200	223,200	223,200	223,200	223,200	223,200
147	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	224,400	224,400	224,400	224,400	224,400	224,400	224,400	224,400	224,400	224,400
148	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	225,600	225,600	225,600	225,600	225,600	225,600	225,600	225,600	225,600	225,600
149	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	226,800	226,800	226,800	226,800	226,800	226,800	226,800	226,800	226,800	226,800
150	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	228,000	228,000	228,000	228,000	228,000	228,000	228,000	228,000	228,000	228,000

● DISTANCE MEASURED TO THE NEAREST FOOT. WHEN EXACTLY 1/2 FOOT OR MORE, ROUND UP TO THE NEXT LARGER NUMBER ●

Figure A3.8 (Continued): Permit Weight Table 3 [Oregon Motor Carrier].

OREGON DEPARTMENT OF TRANSPORTATION
MOTOR CARRIER TRANSPORTATION DIVISION
550 CAPITOL ST NE
SALEM OR 97301-2530

PERMIT WEIGHT TABLE 4

WHEELBASE	2 Axles	3 Axles	4 Axles	5 Axles	6 Axles	7 Axles	8 Axles	9 Axles	10 Axles	11 Axles	12 Axles	13 Axles	14 Axles	15 Axles	16 Axles	17 Axles	18 Axles	19 Axles	20 Axles
4	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000
5	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000
6	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000
7	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000
8	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000
OVER 8' (BUT LESS THAN 8'6")	43,000	57,600	57,600	57,600	57,600	57,600	57,600	57,600	57,600	57,600	57,600	57,600	57,600	57,600	57,600	57,600	57,600	57,600	57,600
9	43,000	58,800	58,800	58,800	58,800	58,800	58,800	58,800	58,800	58,800	58,800	58,800	58,800	58,800	58,800	58,800	58,800	58,800	58,800
10	43,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000
11	43,000	61,200	61,200	61,200	61,200	61,200	61,200	61,200	61,200	61,200	61,200	61,200	61,200	61,200	61,200	61,200	61,200	61,200	61,200
12	43,000	62,400	62,400	62,400	62,400	62,400	62,400	62,400	62,400	62,400	62,400	62,400	62,400	62,400	62,400	62,400	62,400	62,400	62,400
13	43,000	63,600	63,600	63,600	63,600	63,600	63,600	63,600	63,600	63,600	63,600	63,600	63,600	63,600	63,600	63,600	63,600	63,600	63,600
14	43,000	64,500	64,800	64,800	64,800	64,800	64,800	64,800	64,800	64,800	64,800	64,800	64,800	64,800	64,800	64,800	64,800	64,800	64,800
15	43,000	64,500	66,000	66,000	66,000	66,000	66,000	66,000	66,000	66,000	66,000	66,000	66,000	66,000	66,000	66,000	66,000	66,000	66,000
16	43,000	64,500	67,200	67,200	67,200	67,200	67,200	67,200	67,200	67,200	67,200	67,200	67,200	67,200	67,200	67,200	67,200	67,200	67,200
17	43,000	64,500	68,400	68,400	68,400	68,400	68,400	68,400	68,400	68,400	68,400	68,400	68,400	68,400	68,400	68,400	68,400	68,400	68,400
18	43,000	64,500	69,600	69,600	69,600	69,600	69,600	69,600	69,600	69,600	69,600	69,600	69,600	69,600	69,600	69,600	69,600	69,600	69,600
19	43,000	64,500	82,600	82,600	82,600	82,600	82,600	82,600	82,600	82,600	82,600	82,600	82,600	82,600	82,600	82,600	82,600	82,600	82,600
20	43,000	64,500	84,000	84,000	84,000	84,000	84,000	84,000	84,000	84,000	84,000	84,000	84,000	84,000	84,000	84,000	84,000	84,000	84,000
21	43,000	64,500	85,400	85,400	85,400	85,400	85,400	85,400	85,400	85,400	85,400	85,400	85,400	85,400	85,400	85,400	85,400	85,400	85,400
22	43,000	64,500	86,000	86,800	86,800	86,800	86,800	86,800	86,800	86,800	86,800	86,800	86,800	86,800	86,800	86,800	86,800	86,800	86,800
23	43,000	64,500	86,000	88,200	88,200	88,200	88,200	88,200	88,200	88,200	88,200	88,200	88,200	88,200	88,200	88,200	88,200	88,200	88,200
24	43,000	64,500	86,000	89,600	89,600	89,600	89,600	89,600	89,600	89,600	89,600	89,600	89,600	89,600	89,600	89,600	89,600	89,600	89,600
25	43,000	64,500	86,000	91,000	91,000	91,000	91,000	91,000	91,000	91,000	91,000	91,000	91,000	91,000	91,000	91,000	91,000	91,000	91,000
26	43,000	64,500	86,000	92,400	92,400	92,400	92,400	92,400	92,400	92,400	92,400	92,400	92,400	92,400	92,400	92,400	92,400	92,400	92,400
27	43,000	64,500	86,000	93,800	93,800	93,800	93,800	93,800	93,800	93,800	93,800	93,800	93,800	93,800	93,800	93,800	93,800	93,800	93,800
28	43,000	64,500	86,000	95,200	95,200	95,200	95,200	95,200	95,200	95,200	95,200	95,200	95,200	95,200	95,200	95,200	95,200	95,200	95,200
29	43,000	64,500	86,000	96,600	96,600	96,600	96,600	96,600	96,600	96,600	96,600	96,600	96,600	96,600	96,600	96,600	96,600	96,600	96,600
30	43,000	64,500	86,000	98,000	98,000	98,000	98,000	98,000	98,000	98,000	98,000	98,000	98,000	98,000	98,000	98,000	98,000	98,000	98,000
31	43,000	64,500	86,000	99,400	99,400	99,400	99,400	99,400	99,400	99,400	99,400	99,400	99,400	99,400	99,400	99,400	99,400	99,400	99,400
32	43,000	64,500	86,000	100,800	100,800	100,800	100,800	100,800	100,800	100,800	100,800	100,800	100,800	100,800	100,800	100,800	100,800	100,800	100,800
33	43,000	64,500	86,000	102,200	102,200	102,200	102,200	102,200	102,200	102,200	102,200	102,200	102,200	102,200	102,200	102,200	102,200	102,200	102,200
34	43,000	64,500	86,000	103,600	103,600	103,600	103,600	103,600	103,600	103,600	103,600	103,600	103,600	103,600	103,600	103,600	103,600	103,600	103,600
35	43,000	64,500	86,000	105,000	105,000	105,000	105,000	105,000	105,000	105,000	105,000	105,000	105,000	105,000	105,000	105,000	105,000	105,000	105,000
36	43,000	64,500	86,000	106,400	106,400	106,400	106,400	106,400	106,400	106,400	106,400	106,400	106,400	106,400	106,400	106,400	106,400	106,400	106,400
37	43,000	64,500	86,000	107,500	107,800	107,800	107,800	107,800	107,800	107,800	107,800	107,800	107,800	107,800	107,800	107,800	107,800	107,800	107,800
38	43,000	64,500	86,000	107,500	109,200	109,200	109,200	109,200	109,200	109,200	109,200	109,200	109,200	109,200	109,200	109,200	109,200	109,200	109,200
39	43,000	64,500	86,000	107,500	110,600	110,600	110,600	110,600	110,600	110,600	110,600	110,600	110,600	110,600	110,600	110,600	110,600	110,600	110,600
40	43,000	64,500	86,000	107,500	112,000	112,000	112,000	112,000	112,000	112,000	112,000	112,000	112,000	112,000	112,000	112,000	112,000	112,000	112,000
41	43,000	64,500	86,000	107,500	113,400	113,400	113,400	113,400	113,400	113,400	113,400	113,400	113,400	113,400	113,400	113,400	113,400	113,400	113,400
42	43,000	64,500	86,000	107,500	114,800	114,800	114,800	114,800	114,800	114,800	114,800	114,800	114,800	114,800	114,800	114,800	114,800	114,800	114,800
43	43,000	64,500	86,000	107,500	116,200	116,200	116,200	116,200	116,200	116,200	116,200	116,200	116,200	116,200	116,200	116,200	116,200	116,200	116,200
44	43,000	64,500	86,000	107,500	117,600	117,600	117,600	117,600	117,600	117,600	117,600	117,600	117,600	117,600	117,600	117,600	117,600	117,600	117,600
45	43,000	64,500	86,000	107,500	119,000	119,000	119,000	119,000	119,000	119,000	119,000	119,000	119,000	119,000	119,000	119,000	119,000	119,000	119,000
46	43,000	64,500	86,000	107,500	120,400	120,400	120,400	120,400	120,400	120,400	120,400	120,400	120,400	120,400	120,400	120,400	120,400	120,400	120,400
47	43,000	64,500	86,000	107,500	121,800	121,800	121,800	121,800	121,800	121,800	121,800	121,800	121,800	121,800	121,800	121,800	121,800	121,800	121,800
48	43,000	64,500	86,000	107,500	123,200	123,200	123,200	123,200	123,200	123,200	123,200	123,200	123,200	123,200	123,200	123,200	123,200	123,200	123,200
49	43,000	64,500	86,000	107,500	124,600	124,600	124,600	124,600	124,600	124,600	124,600	124,600	124,600	124,600	124,600	124,600	124,600	124,600	124,600
50	43,000	64,500	86,000	107,500	126,000	126,000	126,000	126,000	126,000	126,000	126,000	126,000	126,000	126,000	126,000	126,000	126,000	126,000	126,000
51	43,000	64,500	86,000	107,500	127,400	127,400	127,400	127,400	127,400	127,400	127,400	127,400	127,400	127,400	127,400	127,400	127,400	127,400	127,400
52	43,000	64,500	86,000	107,500	128,800	128,800	128,800	128,800	128,800	128,800	128,800	128,800	128,800	128,800	128,800	128,800	128,800	128,800	128,800
53	43,000	64,500	86,000	107,500	129,000	130,200	130,200	130,200	130,200	130,200	130,200	130,200	130,200	130,200	130,200	130,200	130,200	130,200	130,200
54	43,000	64,500	86,000	107,500	129,000	131,600	131,600	131,600	131,600	131,600	131,600	131,600	131,600	131,600	131,600	131,600	131,600	131,600	131,600
55	43,000	64,500	86,000	107,500	129,000	133,000	133,000	133,000	133,000	133,000	133,000	133,000	133,000	133,000	133,000	133,000	133,000	133,000	133,000
56	43,000	64,500	86,000	107,500	129,000	134,400	134,400	134,400	134,400	134,400	134,400	134,400	134,400	134,400	134,400	134,400	134,400	134,400	134,400
57	43,000	64,500	86,000	107,500	129,000	135,800	135,800	135,800	135,800	135,800	135,800	135,800	135,800	135,800	135,800	135,800	135,800	135,800	135,800
58	43,000	64,500	86,000	107,500	129,000	137,200	137,200	137,200	137,200	137,200	137,200	137,200	137,200	137,200	137,200	137,200	137,200	137,200	137,200
59	43,000	64,500	86,000	107,500	129,000	138,600	138,600	138,600	138,600	138,600	138,600	138,600	138,600	138,600	138,600	138,600	138,600	138,600	138,600
60	43,000	64,500	86,000	107,500	129,000	140,000	140,000	140,000	140,000	140,000	140,000	140,000	140,000	140,000	140,000	140,000	140,000	140,000	140,000
61	43,000	64,500	86,000	107,500	129,000	141,400	141,400	141,400	141,400	141,400	141,400	141,400	141,400	141,400	141,400	141,400	141,400	141,400	141,400
62	43,000	64,500	86,000	107,500	129,000	142,800	142,800	142,800	142,800	142,800	142,800	142,800	142,800	142,800	142,800	142,800	142,800	142,800	142,800
63	43,000	64,500	86,000	107,500	129,000	144,200	144,200	144,200	144,200	144,200	144,200	144,200	144,200	144,200	144,200	144,200	144,200	144,200	144,200
64	43,000	64,500	86,000	107,500	129,000	145,600	145,600	145,600	145,600	145,600	145,600	145,600	145,600	145,600	145,600	145,600	145,600	145,600	145,600
65	43,000	64,500	86,000	107,500	129,000	147,000	147,000	147,000	147,000	147,000	147,000	147,000	147,000	147,000	147,000	147,000	147,000	147,000	147,000
66	43,000	64,500	86,000	107,500	129,000	148,400	148,400	148,400	148,400	148,400	148,400	148,400	148,400	148,400	148,400	148,400	148,400	148,400	148,400
67	43,000	64,500	86,000	107,500	129,000	149,800	149,800	149,800	149,800	149,800	149,800	149,800	149,800	149,800	149,800	149,800	149,800	149,800	149,800
68	43,000	64,500	86,000	107,500	129,000	150,500	151,200	151,200	151,200	151,200	151,200	151,200	151,200	151,200	151,200	151,200	151,200	151,200	151,200
69	43,000	64,500	86,000	107,500	129,000	150,500	152,600	152,600	152,600	152,600	152,600	152,600	152,600	152,600	152,600	152,600	152,600	152,600	152,600
70	43,000	64,500	86,000	107,500	129,000	150,500	154,000	154,000	154,000	154,000	154,000	154,000	154,000	154,000	154,000	164,000	164,000	164,000	164,000

735-8113 (10-99) ● DISTANCE MEASURED TO THE NEAREST FOOT. WHEN EXACTLY 1/2 FOOT OR MORE, ROUND UP TO THE NEXT LARGER NUMBER ● STK # 300560

Figure A3.9: Permit Weight Table 4 [Oregon Motor Carrier].

WHEELBASE	2 Axles	3 Axles	4 Axles	5 Axles	6 Axles	7 Axles	8 Axles	9 Axles	10 Axles	11 Axles	12 Axles	13 Axles	14 Axles	15 Axles	16 Axles	17 Axles	18 Axles	19 Axles	20 Axles
71	43,000	64,500	86,000	107,500	129,000	150,500	155,400	155,400	155,400	155,400	155,400	155,400	155,400	155,400	155,400	155,400	155,400	155,400	155,400
72	43,000	64,500	86,000	107,500	129,000	150,500	156,800	156,800	156,800	156,800	156,800	156,800	156,800	156,800	156,800	156,800	156,800	156,800	156,800
73	43,000	64,500	86,000	107,500	129,000	150,500	158,200	158,200	158,200	158,200	158,200	158,200	158,200	158,200	158,200	158,200	158,200	158,200	158,200
74	43,000	64,500	86,000	107,500	129,000	150,500	159,600	159,600	159,600	159,600	159,600	159,600	159,600	159,600	159,600	159,600	159,600	159,600	159,600
75	43,000	64,500	86,000	107,500	129,000	150,500	161,000	161,000	161,000	161,000	161,000	161,000	161,000	161,000	161,000	161,000	161,000	161,000	161,000
76	43,000	64,500	86,000	107,500	129,000	150,500	162,400	162,400	162,400	162,400	162,400	162,400	162,400	162,400	162,400	162,400	162,400	162,400	162,400
77	43,000	64,500	86,000	107,500	129,000	150,500	163,800	163,800	163,800	163,800	163,800	163,800	163,800	163,800	163,800	163,800	163,800	163,800	163,800
78	43,000	64,500	86,000	107,500	129,000	150,500	165,200	165,200	165,200	165,200	165,200	165,200	165,200	165,200	165,200	165,200	165,200	165,200	165,200
79	43,000	64,500	86,000	107,500	129,000	150,500	166,600	166,600	166,600	166,600	166,600	166,600	166,600	166,600	166,600	166,600	166,600	166,600	166,600
80	43,000	64,500	86,000	107,500	129,000	150,500	168,000	168,000	168,000	168,000	168,000	168,000	168,000	168,000	168,000	168,000	168,000	168,000	168,000
81	43,000	64,500	86,000	107,500	129,000	150,500	169,400	169,400	169,400	169,400	169,400	169,400	169,400	169,400	169,400	169,400	169,400	169,400	169,400
82	43,000	64,500	86,000	107,500	129,000	150,500	170,800	170,800	170,800	170,800	170,800	170,800	170,800	170,800	170,800	170,800	170,800	170,800	170,800
83	43,000	64,500	86,000	107,500	129,000	150,500	172,000	172,200	172,200	172,200	172,200	172,200	172,200	172,200	172,200	172,200	172,200	172,200	172,200
84	43,000	64,500	86,000	107,500	129,000	150,500	172,000	173,600	173,600	173,600	173,600	173,600	173,600	173,600	173,600	173,600	173,600	173,600	173,600
85	43,000	64,500	86,000	107,500	129,000	150,500	172,000	175,000	175,000	175,000	175,000	175,000	175,000	175,000	175,000	175,000	175,000	175,000	175,000
86	43,000	64,500	86,000	107,500	129,000	150,500	172,000	176,400	176,400	176,400	176,400	176,400	176,400	176,400	176,400	176,400	176,400	176,400	176,400
87	43,000	64,500	86,000	107,500	129,000	150,500	172,000	177,800	177,800	177,800	177,800	177,800	177,800	177,800	177,800	177,800	177,800	177,800	177,800
88	43,000	64,500	86,000	107,500	129,000	150,500	172,000	179,200	179,200	179,200	179,200	179,200	179,200	179,200	179,200	179,200	179,200	179,200	179,200
89	43,000	64,500	86,000	107,500	129,000	150,500	172,000	180,600	180,600	180,600	180,600	180,600	180,600	180,600	180,600	180,600	180,600	180,600	180,600
90	43,000	64,500	86,000	107,500	129,000	150,500	172,000	182,000	182,000	182,000	182,000	182,000	182,000	182,000	182,000	182,000	182,000	182,000	182,000
91	43,000	64,500	86,000	107,500	129,000	150,500	172,000	183,400	183,400	183,400	183,400	183,400	183,400	183,400	183,400	183,400	183,400	183,400	183,400
92	43,000	64,500	86,000	107,500	129,000	150,500	172,000	184,800	184,800	184,800	184,800	184,800	184,800	184,800	184,800	184,800	184,800	184,800	184,800
93	43,000	64,500	86,000	107,500	129,000	150,500	172,000	186,200	186,200	186,200	186,200	186,200	186,200	186,200	186,200	186,200	186,200	186,200	186,200
94	43,000	64,500	86,000	107,500	129,000	150,500	172,000	187,600	187,600	187,600	187,600	187,600	187,600	187,600	187,600	187,600	187,600	187,600	187,600
95	43,000	64,500	86,000	107,500	129,000	150,500	172,000	189,000	189,000	189,000	189,000	189,000	189,000	189,000	189,000	189,000	189,000	189,000	189,000
96	43,000	64,500	86,000	107,500	129,000	150,500	172,000	190,400	190,400	190,400	190,400	190,400	190,400	190,400	190,400	190,400	190,400	190,400	190,400
97	43,000	64,500	86,000	107,500	129,000	150,500	172,000	191,800	191,800	191,800	191,800	191,800	191,800	191,800	191,800	191,800	191,800	191,800	191,800
98	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,200	193,200	193,200	193,200	193,200	193,200	193,200	193,200	193,200	193,200	193,200	193,200
99	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	194,600	194,600	194,600	194,600	194,600	194,600	194,600	194,600	194,600	194,600	194,600
100	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	196,000	196,000	196,000	196,000	196,000	196,000	196,000	196,000	196,000	196,000	196,000
101	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	197,400	197,400	197,400	197,400	197,400	197,400	197,400	197,400	197,400	197,400	197,400
102	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	198,800	198,800	198,800	198,800	198,800	198,800	198,800	198,800	198,800	198,800	198,800
103	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	200,200	200,200	200,200	200,200	200,200	200,200	200,200	200,200	200,200	200,200	200,200
104	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	201,600	201,600	201,600	201,600	201,600	201,600	201,600	201,600	201,600	201,600	201,600
105	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	203,000	203,000	203,000	203,000	203,000	203,000	203,000	203,000	203,000	203,000	203,000
106	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	204,400	204,400	204,400	204,400	204,400	204,400	204,400	204,400	204,400	204,400	204,400
107	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	205,800	205,800	205,800	205,800	205,800	205,800	205,800	205,800	205,800	205,800	205,800
108	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	207,200	207,200	207,200	207,200	207,200	207,200	207,200	207,200	207,200	207,200	207,200
109	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	208,600	208,600	208,600	208,600	208,600	208,600	208,600	208,600	208,600	208,600	208,600
110	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	210,000	210,000	210,000	210,000	210,000	210,000	210,000	210,000	210,000	210,000	210,000
111	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	211,400	211,400	211,400	211,400	211,400	211,400	211,400	211,400	211,400	211,400	211,400
112	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	212,800	212,800	212,800	212,800	212,800	212,800	212,800	212,800	212,800	212,800	212,800
113	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	214,200	214,200	214,200	214,200	214,200	214,200	214,200	214,200	214,200	214,200	214,200
114	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	215,600	215,600	215,600	215,600	215,600	215,600	215,600	215,600	215,600	215,600
115	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	217,000	217,000	217,000	217,000	217,000	217,000	217,000	217,000	217,000	217,000
116	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	218,400	218,400	218,400	218,400	218,400	218,400	218,400	218,400	218,400	218,400
117	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	219,800	219,800	219,800	219,800	219,800	219,800	219,800	219,800	219,800	219,800
118	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	221,200	221,200	221,200	221,200	221,200	221,200	221,200	221,200	221,200	221,200
119	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	222,600	222,600	222,600	222,600	222,600	222,600	222,600	222,600	222,600	222,600
120	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	224,000	224,000	224,000	224,000	224,000	224,000	224,000	224,000	224,000	224,000
121	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	225,400	225,400	225,400	225,400	225,400	225,400	225,400	225,400	225,400	225,400
122	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	226,800	226,800	226,800	226,800	226,800	226,800	226,800	226,800	226,800	226,800
123	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	228,200	228,200	228,200	228,200	228,200	228,200	228,200	228,200	228,200	228,200
124	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	229,600	229,600	229,600	229,600	229,600	229,600	229,600	229,600	229,600	229,600
125	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	231,000	231,000	231,000	231,000	231,000	231,000	231,000	231,000	231,000	231,000
126	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	232,400	232,400	232,400	232,400	232,400	232,400	232,400	232,400	232,400	232,400
127	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	233,800	233,800	233,800	233,800	233,800	233,800	233,800	233,800	233,800	233,800
128	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	235,200	235,200	235,200	235,200	235,200	235,200	235,200	235,200	235,200	235,200
129	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	236,500	236,600	236,600	236,600	236,600	236,600	236,600	236,600	236,600	236,600
130	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	236,500	238,000	238,000	238,000	238,000	238,000	238,000	238,000	238,000	238,000
131	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	236,500	239,400	239,400	239,400	239,400	239,400	239,400	239,400	239,400	239,400
132	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	236,500	240,800	240,800	240,800	240,800	240,800	240,800	240,800	240,800	240,800
133	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	236,500	242,200	242,200	242,200	242,200	242,200	242,200	242,200	242,200	242,200
134	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	236,500	243,600	243,600	243,600	243,600	243,600	243,600	243,600	243,600	243,600
135	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	236,500	245,000	245,000	245,000	245,000	245,000	245,000	245,000	245,000	245,000
136	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	236,500	246,400	246,400	246,400	246,400	246,400	246,400	246,400	246,400	246,400
137	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	236,500	247,800	247,800	247,800	247,800	247,800	247,800	247,800	247,800	247,800
138	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	236,500	249,200	249,200	249,200	249,200	249,200	249,200	249,200	249,200	249,200
139	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	236,500	250,600	250,600	250,600	250,600	250,600	250,600	250,600	250,600	250,600
140	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	236,500	252,000	252,000	252,000	252,000	252,000	252,000	252,000	252,000	252,000
141	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	236,500	253,400	253,400	253,400	253,400	253,400	253,400	253,400	253,400	253,400
142	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	236,500	254,800	254,800	254,800	254,800	254,800	254,800	254,800	254,800	254,800
143	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	236,500	256,200	256,200	256,200	256,200	256,200	256,200	256,200	256,200	256,200
144	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	236,500	257,600	257,600	257,600	257,600	257,600	257,600	257,600	257,600	257,600
145	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	236,500	258,000	259,000	259,000	259,000	259,000	259,000	259,000	259,000	259,000
146	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	236,500	258,000	260,400	260,400	260,400	260,400	260,400	260,400	260,400	260,400
147	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	236,500	258,000	261,800	261,800	261,800	261,800	261,800	261,800	261,800	261,800
148	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	236,500	258,000	263,200	263,200	263,200	263,200	263,200	263,200	263,200	263,200
149	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	236,500	258,000	264,600	264,600	264,600	264,600	264,600	264,600	264,600	264,600
150	43,000	64,500	86,000	107,500	129,000	150,500	172,000	193,500	215,000	236,500	258,000	266,000	266,000	266,000	266,000	266,000	266,000	266,000	266,000

● DISTANCE MEASURED TO THE NEAREST FOOT. WHEN EXACTLY 1/2 FOOT OR MORE, ROUND UP TO THE NEXT LARGER NUMBER ●

Figure A3.9 (Continued): Permit Weight Table 4 [Oregon Motor Carrier].

OREGON DEPARTMENT OF TRANSPORTATION
MOTOR CARRIER TRANSPORTATION DIVISION
550 CAPITOL ST NE
SALEM OR 97301-2530

PERMIT WEIGHT TABLE 5

WHEELBASE	2 Axles	3 Axles	4 Axles	5 Axles	6 Axles	7 Axles	8 Axles	9 Axles	10 Axles	11 Axles	12 Axles	13 Axles	14 Axles	15 Axles	16 Axles	17 Axles	18 Axles	19 Axles	20 Axles
4	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000
5	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000
6	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000
7	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000
8	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000	43,000
OVER 8' (BUT LESS THEN 8'6")	43,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000
9	43,000	58,500	58,500	58,500	58,500	58,500	58,500	58,500	58,500	58,500	58,500	58,500	58,500	58,500	58,500	58,500	58,500	58,500	58,500
10	43,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000
11	43,000	68,200	68,200	68,200	68,200	68,200	68,200	68,200	68,200	68,200	68,200	68,200	68,200	68,200	68,200	68,200	68,200	68,200	68,200
12	43,000	70,400	70,400	70,400	70,400	70,400	70,400	70,400	70,400	70,400	70,400	70,400	70,400	70,400	70,400	70,400	70,400	70,400	70,400
13	43,000	72,000	72,600	72,600	72,600	72,600	72,600	72,600	72,600	72,600	72,600	72,600	72,600	72,600	72,600	72,600	72,600	72,600	72,600
14	43,000	72,000	74,800	74,800	74,800	74,800	74,800	74,800	74,800	74,800	74,800	74,800	74,800	74,800	74,800	74,800	74,800	74,800	74,800
15	43,000	72,000	77,000	77,000	77,000	77,000	77,000	77,000	77,000	77,000	77,000	77,000	77,000	77,000	77,000	77,000	77,000	77,000	77,000
16	43,000	72,000	79,200	79,200	79,200	79,200	79,200	79,200	79,200	79,200	79,200	79,200	79,200	79,200	79,200	79,200	79,200	79,200	79,200
17	43,000	72,000	81,400	81,400	81,400	81,400	81,400	81,400	81,400	81,400	81,400	81,400	81,400	81,400	81,400	81,400	81,400	81,400	81,400
18	43,000	72,000	83,600	83,600	83,600	83,600	83,600	83,600	83,600	83,600	83,600	83,600	83,600	83,600	83,600	83,600	83,600	83,600	83,600
19	43,000	72,000	85,800	85,800	85,800	85,800	85,800	85,800	85,800	85,800	85,800	85,800	85,800	85,800	85,800	85,800	85,800	85,800	85,800
20	43,000	72,000	88,000	88,000	88,000	88,000	88,000	88,000	88,000	88,000	88,000	88,000	88,000	88,000	88,000	88,000	88,000	88,000	88,000
21	43,000	72,000	90,200	90,200	90,200	90,200	90,200	90,200	90,200	90,200	90,200	90,200	90,200	90,200	90,200	90,200	90,200	90,200	90,200
22	43,000	72,000	92,400	92,400	92,400	92,400	92,400	92,400	92,400	92,400	92,400	92,400	92,400	92,400	92,400	92,400	92,400	92,400	92,400
23	43,000	72,000	94,600	94,600	94,600	94,600	94,600	94,600	94,600	94,600	94,600	94,600	94,600	94,600	94,600	94,600	94,600	94,600	94,600
24	43,000	72,000	96,000	96,800	96,800	96,800	96,800	96,800	96,800	96,800	96,800	96,800	96,800	96,800	96,800	96,800	96,800	96,800	96,800
25	43,000	72,000	96,000	99,000	99,000	99,000	99,000	99,000	99,000	99,000	99,000	99,000	99,000	99,000	99,000	99,000	99,000	99,000	99,000
26	43,000	72,000	96,000	101,200	101,200	101,200	101,200	101,200	101,200	101,200	101,200	101,200	101,200	101,200	101,200	101,200	101,200	101,200	101,200
27	43,000	72,000	96,000	103,400	103,400	103,400	103,400	103,400	103,400	103,400	103,400	103,400	103,400	103,400	103,400	103,400	103,400	103,400	103,400
28	43,000	72,000	96,000	105,600	105,600	105,600	105,600	105,600	105,600	105,600	105,600	105,600	105,600	105,600	105,600	105,600	105,600	105,600	105,600
29	43,000	72,000	96,000	107,800	107,800	107,800	107,800	107,800	107,800	107,800	107,800	107,800	107,800	107,800	107,800	107,800	107,800	107,800	107,800
30	43,000	72,000	96,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000
31	43,000	72,000	96,000	113,600	113,600	113,600	113,600	113,600	113,600	113,600	113,600	113,600	113,600	113,600	113,600	113,600	113,600	113,600	113,600
32	43,000	72,000	96,000	115,200	115,200	115,200	115,200	115,200	115,200	115,200	115,200	115,200	115,200	115,200	115,200	115,200	115,200	115,200	115,200
33	43,000	72,000	96,000	116,800	116,800	116,800	116,800	116,800	116,800	116,800	116,800	116,800	116,800	116,800	116,800	116,800	116,800	116,800	116,800
34	43,000	72,000	96,000	118,400	118,400	118,400	118,400	118,400	118,400	118,400	118,400	118,400	118,400	118,400	118,400	118,400	118,400	118,400	118,400
35	43,000	72,000	96,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000
36	43,000	72,000	96,000	120,000	121,600	121,600	121,600	121,600	121,600	121,600	121,600	121,600	121,600	121,600	121,600	121,600	121,600	121,600	121,600
37	43,000	72,000	96,000	120,000	123,200	123,200	123,200	123,200	123,200	123,200	123,200	123,200	123,200	123,200	123,200	123,200	123,200	123,200	123,200
38	43,000	72,000	96,000	120,000	124,800	124,800	124,800	124,800	124,800	124,800	124,800	124,800	124,800	124,800	124,800	124,800	124,800	124,800	124,800
39	43,000	72,000	96,000	120,000	126,400	126,400	126,400	126,400	126,400	126,400	126,400	126,400	126,400	126,400	126,400	126,400	126,400	126,400	126,400
40	43,000	72,000	96,000	120,000	128,000	128,000	128,000	128,000	128,000	128,000	128,000	128,000	128,000	128,000	128,000	128,000	128,000	128,000	128,000
41	43,000	72,000	96,000	120,000	129,600	129,600	129,600	129,600	129,600	129,600	129,600	129,600	129,600	129,600	129,600	129,600	129,600	129,600	129,600
42	43,000	72,000	96,000	120,000	131,200	131,200	131,200	131,200	131,200	131,200	131,200	131,200	131,200	131,200	131,200	131,200	131,200	131,200	131,200
43	43,000	72,000	96,000	120,000	132,800	132,800	132,800	132,800	132,800	132,800	132,800	132,800	132,800	132,800	132,800	132,800	132,800	132,800	132,800
44	43,000	72,000	96,000	120,000	134,400	134,400	134,400	134,400	134,400	134,400	134,400	134,400	134,400	134,400	134,400	134,400	134,400	134,400	134,400
45	43,000	72,000	96,000	120,000	136,000	136,000	136,000	136,000	136,000	136,000	136,000	136,000	136,000	136,000	136,000	136,000	136,000	136,000	136,000
46	43,000	72,000	96,000	120,000	137,600	137,600	137,600	137,600	137,600	137,600	137,600	137,600	137,600	137,600	137,600	137,600	137,600	137,600	137,600
47	43,000	72,000	96,000	120,000	139,200	139,200	139,200	139,200	139,200	139,200	139,200	139,200	139,200	139,200	139,200	139,200	139,200	139,200	139,200
48	43,000	72,000	96,000	120,000	140,800	140,800	140,800	140,800	140,800	140,800	140,800	140,800	140,800	140,800	140,800	140,800	140,800	140,800	140,800
49	43,000	72,000	96,000	120,000	142,400	142,400	142,400	142,400	142,400	142,400	142,400	142,400	142,400	142,400	142,400	142,400	142,400	142,400	142,400
50	43,000	72,000	96,000	120,000	144,000	144,000	144,000	144,000	144,000	144,000	144,000	144,000	144,000	144,000	144,000	144,000	144,000	144,000	144,000
51	43,000	72,000	96,000	120,000	144,000	145,600	145,600	145,600	145,600	145,600	145,600	145,600	145,600	145,600	145,600	145,600	145,600	145,600	145,600
52	43,000	72,000	96,000	120,000	144,000	147,200	147,200	147,200	147,200	147,200	147,200	147,200	147,200	147,200	147,200	147,200	147,200	147,200	147,200
53	43,000	72,000	96,000	120,000	144,000	148,800	148,800	148,800	148,800	148,800	148,800	148,800	148,800	148,800	148,800	148,800	148,800	148,800	148,800
54	43,000	72,000	96,000	120,000	144,000	150,400	150,400	150,400	150,400	150,400	150,400	150,400	150,400	150,400	150,400	150,400	150,400	150,400	150,400
55	43,000	72,000	96,000	120,000	144,000	152,000	152,000	152,000	152,000	152,000	152,000	152,000	152,000	152,000	152,000	152,000	152,000	152,000	152,000
56	43,000	72,000	96,000	120,000	144,000	153,600	153,600	153,600	153,600	153,600	153,600	153,600	153,600	153,600	153,600	153,600	153,600	153,600	153,600
57	43,000	72,000	96,000	120,000	144,000	155,200	155,200	155,200	155,200	155,200	155,200	155,200	155,200	155,200	155,200	155,200	155,200	155,200	155,200
58	43,000	72,000	96,000	120,000	144,000	156,800	156,800	156,800	156,800	156,800	156,800	156,800	156,800	156,800	156,800	156,800	156,800	156,800	156,800
59	43,000	72,000	96,000	120,000	144,000	158,400	158,400	158,400	158,400	158,400	158,400	158,400	158,400	158,400	158,400	158,400	158,400	158,400	158,400
60	43,000	72,000	96,000	120,000	144,000	160,000	160,000	160,000	160,000	160,000	160,000	160,000	160,000	160,000	160,000	160,000	160,000	160,000	160,000
61	43,000	72,000	96,000	120,000	144,000	161,600	161,600	161,600	161,600	161,600	161,600	161,600	161,600	161,600	161,600	161,600	161,600	161,600	161,600
62	43,000	72,000	96,000	120,000	144,000	163,200	163,200	163,200	163,200	163,200	163,200	163,200	163,200	163,200	163,200	163,200	163,200	163,200	163,200
63	43,000	72,000	96,000	120,000	144,000	164,800	164,800	164,800	164,800	164,800	164,800	164,800	164,800	164,800	164,800	164,800	164,800	164,800	164,800
64	43,000	72,000	96,000	120,000	144,000	166,400	166,400	166,400	166,400	166,400	166,400	166,400	166,400	166,400	166,400	166,400	166,400	166,400	166,400
65	43,000	72,000	96,000	120,000	144,000	168,000	168,000	168,000	168,000	168,000	168,000	168,000	168,000	168,000	168,000	168,000	168,000	168,000	168,000
66	43,000	72,000	96,000	120,000	144,000	168,000	169,600	169,600	169,600	169,600	169,600	169,600	169,600	169,600	169,600	169,600	169,600	169,600	169,600
67	43,000	72,000	96,000	120,000	144,000	168,000	171,200	171,200	171,200	171,200	171,200	171,200	171,200	171,200	171,200	171,200	171,200	171,200	171,200
68	43,000	72,000	96,000	120,000	144,000	168,000	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800	172,800
69	43,000	72,000	96,000	120,000	144,000	168,000	174,400	174,400	174,400	174,400	174,400	174,400	174,400	174,400	174,400	174,400	174,400	174,400	174,400
70	43,000	72,000	96,000	120,000	144,000	168,000	176,000	176,000	176,000	176,000	176,000	176,000	176,000	176,000	176,000	176,000	176,000	176,000	176,000

735-8114 (10-99) ● DISTANCE MEASURED TO THE NEAREST FOOT. WHEN EXACTLY 1/2 FOOT OR MORE, ROUND UP TO THE NEXT LARGER NUMBER ● STK # 300561

Figure A3.10: Permit Weight Table 5 [Oregon Motor Carrier].

WHEELBASE	2 Axles	3 Axles	4 Axles	5 Axles	6 Axles	7 Axles	8 Axles	9 Axles	10 Axles	11 Axles	12 Axles	13 Axles	14 Axles	15 Axles	16 Axles	17 Axles	18 Axles	19 Axles	20 Axles
71	43,000	72,000	96,000	120,000	144,000	168,000	177,600	177,600	177,600	177,600	177,600	177,600	177,600	177,600	177,600	177,600	177,600	177,600	177,600
72	43,000	72,000	96,000	120,000	144,000	168,000	179,200	179,200	179,200	179,200	179,200	179,200	179,200	179,200	179,200	179,200	179,200	179,200	179,200
73	43,000	72,000	96,000	120,000	144,000	168,000	180,800	180,800	180,800	180,800	180,800	180,800	180,800	180,800	180,800	180,800	180,800	180,800	180,800
74	43,000	72,000	96,000	120,000	144,000	168,000	182,400	182,400	182,400	182,400	182,400	182,400	182,400	182,400	182,400	182,400	182,400	182,400	182,400
75	43,000	72,000	96,000	120,000	144,000	168,000	184,000	184,000	184,000	184,000	184,000	184,000	184,000	184,000	184,000	184,000	184,000	184,000	184,000
76	43,000	72,000	96,000	120,000	144,000	168,000	185,600	185,600	185,600	185,600	185,600	185,600	185,600	185,600	185,600	185,600	185,600	185,600	185,600
77	43,000	72,000	96,000	120,000	144,000	168,000	187,200	187,200	187,200	187,200	187,200	187,200	187,200	187,200	187,200	187,200	187,200	187,200	187,200
78	43,000	72,000	96,000	120,000	144,000	168,000	188,800	188,800	188,800	188,800	188,800	188,800	188,800	188,800	188,800	188,800	188,800	188,800	188,800
79	43,000	72,000	96,000	120,000	144,000	168,000	190,400	190,400	190,400	190,400	190,400	190,400	190,400	190,400	190,400	190,400	190,400	190,400	190,400
80	43,000	72,000	96,000	120,000	144,000	168,000	192,000	192,000	192,000	192,000	192,000	192,000	192,000	192,000	192,000	192,000	192,000	192,000	192,000
81	43,000	72,000	96,000	120,000	144,000	168,000	192,000	193,600	193,600	193,600	193,600	193,600	193,600	193,600	193,600	193,600	193,600	193,600	193,600
82	43,000	72,000	96,000	120,000	144,000	168,000	192,000	195,200	195,200	195,200	195,200	195,200	195,200	195,200	195,200	195,200	195,200	195,200	195,200
83	43,000	72,000	96,000	120,000	144,000	168,000	192,000	196,800	196,800	196,800	196,800	196,800	196,800	196,800	196,800	196,800	196,800	196,800	196,800
84	43,000	72,000	96,000	120,000	144,000	168,000	192,000	198,400	198,400	198,400	198,400	198,400	198,400	198,400	198,400	198,400	198,400	198,400	198,400
85	43,000	72,000	96,000	120,000	144,000	168,000	192,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000
86	43,000	72,000	96,000	120,000	144,000	168,000	192,000	201,600	201,600	201,600	201,600	201,600	201,600	201,600	201,600	201,600	201,600	201,600	201,600
87	43,000	72,000	96,000	120,000	144,000	168,000	192,000	203,200	203,200	203,200	203,200	203,200	203,200	203,200	203,200	203,200	203,200	203,200	203,200
88	43,000	72,000	96,000	120,000	144,000	168,000	192,000	204,800	204,800	204,800	204,800	204,800	204,800	204,800	204,800	204,800	204,800	204,800	204,800
89	43,000	72,000	96,000	120,000	144,000	168,000	192,000	206,400	206,400	206,400	206,400	206,400	206,400	206,400	206,400	206,400	206,400	206,400	206,400
90	43,000	72,000	96,000	120,000	144,000	168,000	192,000	208,000	208,000	208,000	208,000	208,000	208,000	208,000	208,000	208,000	208,000	208,000	208,000
91	43,000	72,000	96,000	120,000	144,000	168,000	192,000	209,600	209,600	209,600	209,600	209,600	209,600	209,600	209,600	209,600	209,600	209,600	209,600
92	43,000	72,000	96,000	120,000	144,000	168,000	192,000	211,200	211,200	211,200	211,200	211,200	211,200	211,200	211,200	211,200	211,200	211,200	211,200
93	43,000	72,000	96,000	120,000	144,000	168,000	192,000	212,800	212,800	212,800	212,800	212,800	212,800	212,800	212,800	212,800	212,800	212,800	212,800
94	43,000	72,000	96,000	120,000	144,000	168,000	192,000	214,400	214,400	214,400	214,400	214,400	214,400	214,400	214,400	214,400	214,400	214,400	214,400
95	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000
96	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	217,600	217,600	217,600	217,600	217,600	217,600	217,600	217,600	217,600	217,600	217,600
97	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	219,200	219,200	219,200	219,200	219,200	219,200	219,200	219,200	219,200	219,200	219,200
98	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	220,800	220,800	220,800	220,800	220,800	220,800	220,800	220,800	220,800	220,800	220,800
99	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	222,400	222,400	222,400	222,400	222,400	222,400	222,400	222,400	222,400	222,400	222,400
100	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	224,000	224,000	224,000	224,000	224,000	224,000	224,000	224,000	224,000	224,000	224,000
101	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	225,600	225,600	225,600	225,600	225,600	225,600	225,600	225,600	225,600	225,600	225,600
102	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	227,200	227,200	227,200	227,200	227,200	227,200	227,200	227,200	227,200	227,200	227,200
103	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	228,800	228,800	228,800	228,800	228,800	228,800	228,800	228,800	228,800	228,800	228,800
104	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	230,400	230,400	230,400	230,400	230,400	230,400	230,400	230,400	230,400	230,400	230,400
105	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	232,000	232,000	232,000	232,000	232,000	232,000	232,000	232,000	232,000	232,000	232,000
106	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	233,600	233,600	233,600	233,600	233,600	233,600	233,600	233,600	233,600	233,600	233,600
107	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	235,200	235,200	235,200	235,200	235,200	235,200	235,200	235,200	235,200	235,200	235,200
108	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	236,800	236,800	236,800	236,800	236,800	236,800	236,800	236,800	236,800	236,800	236,800
109	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	238,400	238,400	238,400	238,400	238,400	238,400	238,400	238,400	238,400	238,400	238,400
110	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000	240,000
111	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	241,600	241,600	241,600	241,600	241,600	241,600	241,600	241,600	241,600	241,600
112	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	243,200	243,200	243,200	243,200	243,200	243,200	243,200	243,200	243,200	243,200
113	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	244,800	244,800	244,800	244,800	244,800	244,800	244,800	244,800	244,800	244,800
114	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	246,400	246,400	246,400	246,400	246,400	246,400	246,400	246,400	246,400	246,400
115	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	248,000	248,000	248,000	248,000	248,000	248,000	248,000	248,000	248,000	248,000
116	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	249,600	249,600	249,600	249,600	249,600	249,600	249,600	249,600	249,600	249,600
117	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	251,200	251,200	251,200	251,200	251,200	251,200	251,200	251,200	251,200	251,200
118	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	252,800	252,800	252,800	252,800	252,800	252,800	252,800	252,800	252,800	252,800
119	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	254,400	254,400	254,400	254,400	254,400	254,400	254,400	254,400	254,400	254,400
120	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	256,000	256,000	256,000	256,000	256,000	256,000	256,000	256,000	256,000	256,000
121	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	257,600	257,600	257,600	257,600	257,600	257,600	257,600	257,600	257,600	257,600
122	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	259,200	259,200	259,200	259,200	259,200	259,200	259,200	259,200	259,200	259,200
123	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	260,800	260,800	260,800	260,800	260,800	260,800	260,800	260,800	260,800	260,800
124	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	262,400	262,400	262,400	262,400	262,400	262,400	262,400	262,400	262,400	262,400
125	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	264,000	264,000	264,000	264,000	264,000	264,000	264,000	264,000	264,000	264,000
126	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	264,000	265,600	265,600	265,600	265,600	265,600	265,600	265,600	265,600	265,600
127	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	264,000	267,200	267,200	267,200	267,200	267,200	267,200	267,200	267,200	267,200
128	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	264,000	268,800	268,800	268,800	268,800	268,800	268,800	268,800	268,800	268,800
129	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	264,000	270,400	270,400	270,400	270,400	270,400	270,400	270,400	270,400	270,400
130	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	264,000	272,000	272,000	272,000	272,000	272,000	272,000	272,000	272,000	272,000
131	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	264,000	273,600	273,600	273,600	273,600	273,600	273,600	273,600	273,600	273,600
132	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	264,000	275,200	275,200	275,200	275,200	275,200	275,200	275,200	275,200	275,200
133	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	264,000	276,800	276,800	276,800	276,800	276,800	276,800	276,800	276,800	276,800
134	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	264,000	278,400	278,400	278,400	278,400	278,400	278,400	278,400	278,400	278,400
135	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	264,000	280,000	280,000	280,000	280,000	280,000	280,000	280,000	280,000	280,000
136	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	264,000	281,600	281,600	281,600	281,600	281,600	281,600	281,600	281,600	281,600
137	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	264,000	283,200	283,200	283,200	283,200	283,200	283,200	283,200	283,200	283,200
138	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	264,000	284,800	284,800	284,800	284,800	284,800	284,800	284,800	284,800	284,800
139	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	264,000	286,400	286,400	286,400	286,400	286,400	286,400	286,400	286,400	286,400
140	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	264,000	288,000	288,000	288,000	288,000	288,000	288,000	288,000	288,000	288,000
141	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	264,000	288,000	289,600	289,600	289,600	289,600	289,600	289,600	289,600	289,600
142	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	264,000	288,000	291,200	291,200	291,200	291,200	291,200	291,200	291,200	291,200
143	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	264,000	288,000	292,800	292,800	292,800	292,800	292,800	292,800	292,800	292,800
144	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	264,000	288,000	294,400	294,400	294,400	294,400	294,400	294,400	294,400	294,400
145	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	264,000	288,000	296,000	296,000	296,000	296,000	296,000	296,000	296,000	296,000
146	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	264,000	288,000	297,600	297,600	297,600	297,600	297,600	297,600	297,600	297,600
147	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	264,000	288,000	299,200	299,200	299,200	299,200	299,200	299,200	299,200	299,200
148	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	264,000	288,000	300,800	300,800	300,800	300,800	300,800	300,800	300,800	300,800
149	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	264,000	288,000	302,400	302,400	302,400	302,400	302,400	302,400	302,400	302,400
150	43,000	72,000	96,000	120,000	144,000	168,000	192,000	216,000	240,000	264,000	288,000	304,000	304,000	304,000	304,000	304,000	304,000	304,000	304,000

● DISTANCE MEASURED TO THE NEAREST FOOT. WHEN EXACTLY 1/2 FOOT OR MORE, ROUND UP TO THE NEXT LARGER NUMBER ●

Figure A3.10 (Continued): Permit Weight Table 5 [Oregon Motor Carrier].

APPENDIX B

Justification for Liger Filters

In order to obtain the highest quality of data possible, the WIM files need to be cleaned and filtered. The Liger program is the second of two cleaning programs, and its use depends on the output of the first program, Wingnut. Liger checks all vehicle records to make sure they contain realistic numerical values and are free from invalid characters. The Liger program employs 14 different filters, which are covered in more detail herein. An error counter is included for each error category to help point out areas of concern for the WIM files. Each record that contains an error is removed from the file and written to a separate error file, called Liger_Errors.txt. At the end of the error file, the total number of each type of error is displayed. See figure 1 for an error file example.

```
 Mon Jun 28 23:11:25.12 2004   8   A   65  17.5  42.0   50   4   0.067   4.9  8.3  1.8  2.5  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  14.1
Line 325 Error - Spacing < 3.4 ft

 Mon Jun 28 23:28:22.94 2004  13   A   54  12.9  44.6   54   5   0.022   3.2  6.4  1.1  1.1  1.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  13.3
Line 325 Error - Spacing < 3.4 ft

 Mon Jun 28 23:28:30.56 2004   8   A   51  13.4  32.8   43   4   0.019   4.7  5.6  1.9  1.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  13.3
Line 325 Error - Spacing < 3.4 ft

 Mon Jun 28 23:42:24.98 2004   8   A   54  15.4  34.6   41   4   0.082   4.2  8.9  1.1  1.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  14.0
Line 325 Error - Spacing < 3.4 ft

 Mon Jun 28 23:51:13.66 2004   8   A   69  10.8  32.7   40   4   0.009   4.4  4.2  1.0  1.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  13.6
Line 325 Error - Spacing < 3.4 ft

Truck Count from wingnut output:
 NO. OF VALID TRUCKS =      38867  NO. OF NULL TRUCKS=      15129

Total no. of valid trucks from Liger =  36265
Total no. of null trucks from Liger =  2602

Error142  Error165  Error177  Error202  Error216  Error229  Error242  Error256  Error269  Error282  Error296  Error309  Error325  Error344
       0         0         0         0         0         0         0        12         5        25         0         0      2560         0
```

Figure B3.1: Sample error file showing the end of the record produced by the Liger program.

In addition to the Liger_Errors.txt file, another error file is created, called Liger_Special_Errors.txt. This file records errors that require a closer look, such as Error 202, which tosses records where an individual axle is greater than 50 kips.

Each error is named with a number, which corresponds to the actual line in the FORTRAN code where it can be found. However, after numerous revisions to the program, the number and the line of code no longer match.

Invalid Character Filters

The following three filters can be categorized as invalid character filters. These filters check the line for inconsistencies, and are easy to pick out.

Error 142 – Invalid Date

This error checks to see if the date stamp is of ordinary format. For instance, an ordinary date stamp looks like this: `Mon Jun 28 23:11:25.12 2004`

The 15th character in this statement is a colon (:), and the 25th-27th characters in this statement are the numbers (200). Both of these conditions should be true for each valid record. If not, then the record is tossed, and 1 is added to the Error 142 counter. Having either one of these conditions be false compromises the records' validity, and suggests that other characters might be incorrect also.

Error 165 – Non-Numerical Value

This error checks to see if characters 28 through 222 contain a non-numerical value. This includes all letters and symbols. The exception to this is at character 37, which allows the letters 'A', 'B', and 'C' to pass, which are sometimes used as lane signifiers, as an alternative to '1', '2', and '3'. All programs that are used for statistics and analysis depend on the cleaned Liger file. That makes this particular error an important one, because future programs can only read numerical input values for characters 28-222.

Error 177 – Decimal Value in Wrong Place

This error checks to see if characters 25 through 49 and 61 through 76 contain a decimal point ('.'). This is a continuation from Error 165 in that it checks two sub-ranges inside of a larger range for misplaced decimal points. During the early phases of the cleaning process, certain data files would crash the program because of this problem.

Vehicle-Specific Filters

The rest of the error filters are specific to the vehicle itself. Some are justified based on physical constraints and others on engineering judgment. Four of the errors are worth a second look and are written to a second error file, named Liger_Special_Errors.txt. These errors are further investigated to see if the data is truly valid or not.

Error 202 – Individual Axle Weight > 50 kips

This error checks to see if a record contains an individual axle weight greater than 50 kips. This value was logically chosen based on how much weight, or pressure, a vehicle's tire can actually withstand. The 50-kip recommendation came from Dr.

Chris Higgins. This error is one of the four that is written to the Liger_Special_Errors.txt file for further investigation. Several of the data files had 40-50 records where individual axles were greater than 50 kips. Upon investigation, these records were deemed bogus and tossed out.

Error 216 – Speed < 10 mph

This error checks to see if the vehicle's speed is less than 10 mph. The speed of 10 mph was recommended by Bala Sivakumar of Lichtenstein Consulting Engineers, Inc. In his experience, vehicles traveling below 10 mph usually provide skewed data because the WIM equipment is not apt to handle such low speeds. Low speeds also imply traffic jams, which the equipment is not set up to handle.

Error 229 – Speed > 99 mph

This error checks to see if the vehicle's speed is greater than 99 mph. This speed was chosen as a cap value because it is highly unlikely that a vehicle, namely a truck, travels over 100 mph. A record with this error is probably bad in the first place and should be tossed. This error is written to the Liger_Special_Errors.txt for further investigation.

Error 242 – Length > 200 ft

This error checks to see if the vehicle's length, both bumper-to-bumper and rear-to-steer axle, is greater than 200 ft. Vehicles usually do not exceed 200 ft in length.

The records that do exceed 200 ft are written to the Liger_Special_Errors.txt for further investigation. The need for this filter was a result of several files having bad length data.

Error 256 – Bumper-to-Bumper Length + 10 ft < Rear-to-Steer Axle Length

This error checks to see if the bumper-to-bumper length of a vehicle, plus 10 ft, is less than the rear-to-steer axle length. This filter is used as in internal check to see if the records are valid and consistent. It is not physically possible for the rear-to-steer axle length to be greater than the bumper-to-bumper length, but calibration problems with the WIM equipment sometimes show this to be true.

According to David Fifer, who is the Oregon Department of Transportation's (ODOT) Intelligent Transportation Systems Specialist, inductance loops are used to measure the overall bumper-to-bumper length – one upstream and one downstream. Each loop is cut into the roadway in a 6ft square. Generally, the distance between the back of the upstream loop (Loop 1) to the front of the downstream loop (Loop 2) is 22.167 ft. Loop 1 starts the whole process as soon as it detects metal, which indicates when a vehicle "event" begins. The event ends when it no longer detects any metal. Loop 2 reacts in the same manner. A speed-distance formula is then used to calculate the "length" of the event. The bumper-to-bumper length accuracy of any event is dependent on when each loop begins and ceases to detect a vehicle.

According to Fifer, ODOT has the ability to dictate the process of when an event begins and ends. Each loop can be individually configured to expand or condense its "capture field." Once they've been properly calibrated, the information is very accurate/reliable. Occasionally though, because of age, traffic volume, condition of the roadway, etc., one or both loops can fall slightly out of calibration, giving longer or shorter length values. When this happens, ODOT reconfigures either or both to the proper level of accuracy. To account for this potential error in calibration, Error 256 adds 10 ft on to the bumper-to-bumper length. The September 2005 data file for La Grande EB has over 21,000 records where the bumper-to-bumper length is less than the rear-to-steer axle length, most being over by 2-5 ft. Once the 10 ft was added in, the number of errors was reduced to below 100.

The individual axle spacing lengths are derived by a combination of single load cell sensors and Dynax axle sensors. When each sensor is "hit" it counts an axle. The same type of speed-distance formula is used to calculate the distance between the axles. The sum of all axle spacing lengths provide the length of a vehicle's wheel base (center hub of the front axle to the center hub of the rear axle), or rear-to-steer axle length.

It seems highly unlikely that the equipment would be out of calibration so much that the difference between the two values would exceed 10 ft. Upon inspection it was noted that the records which did exceed 10ft in difference had inconsistencies making them "bad".

Error 269 – Bumper-to-Bumper Length & Rear-to-Steer Axle Length < 7 ft

This error checks to see if the bumper-to-bumper or rear-to-steer axle lengths are less than 7 ft. This filter was created to toss erroneous records from the file. It was noticed that sometimes the equipment would record incorrect length values. This could result from either of the inductance loops not picking up a correct starting or ending point of a vehicle.

Error 282 – Steer Axle < 5ft

This error checks to see if the steer axle is less than 5 ft from the second axle. Dr. Higgins suggested this value because vehicles cannot physically have a steer tandem. This error occurs on events that end prematurely, before the truck has completed crossing the loops, therefore beginning a new event starting with the tandem of the next trailer. This error is more common with the data that has first been adjusted by the WIM program rather than by the Wingnut program.

Error 296 – Axle # NE 1-13

This error checks to see if the axle number is not equal to 1 through 13. This would suggest an erroneous record, which would be tossed. Oregon does not allow vehicles to have greater than 13 total axles.

Error 309 – GVW > 280 kips

This error checks to see if the gross vehicle weight (GVW) is greater than 280 kips. Exceeding this value is highly unlikely. Records that are over 280 kips are written to the Liger_Special_Errors.txt for further investigation. This roughly equals 24 kips per axle for a 12 axle vehicle.

Error 325 – Any Axle Spacing < 3.4 ft

This error checks to see if any axle is less than 3.4 ft from the next axle on the vehicle. Tires have limitations on how close they can be spaced to each other before touching. This value is just below 4 ft. The reason 3.4 ft is used instead of 4 ft is to encompass all possible calibration errors that might be present. This is the most common error found in data files that are of the new format (those processed by Wingnut). Vehicles that are below this mark usually have an accompanying error in the original raw record, which looks like this: `Warning: UnAx !` According to Fifer, this warning means there was an "unequal axles detected" error. This is the result of the dynax axle sensor picking up only one side of one of the axles (either the left or right) causing an unequal count - 3 on the left side, and 4 on the right. This occasionally happens when a vehicle doesn't hit the sensors square (may be in the process of changing lanes).

Error 344 – GVW > +/- 7% of the Sum of the Axle Weights

This error checks to see if the gross vehicle weight value differs from the sum of the axle weights by more than 7%. Like Error 256, this filter is an internal check for consistency within the record itself.

List of Errors

Invalid Character Filters

Error 142 – Invalid Date ((15:15) does not equal ':' and (25:27) does not equal '200')
Error 165 – Non-Numerical Value (char. 28 through 222 contains a non-numerical value)
Error 177 – Decimal Value in Wrong Place

Vehicle-Specific Filters

Error 202 – Individual Axle Weight > 50 kips
Error 216 – Speed < 10 mph
Error 229 – Speed > 99 mph
Error 242 – Length > 200 ft
Error 256 – Bumper-to-Bumper Length + 10 ft < The Sum of the Axle Spacings
Error 269 – Length < 7 ft AND Sum of Axles < 7 ft
Error 282 – 1st Axle Spacing < 5 ft (steer axle)
Error 296 – Axle # does not Equal 1 - 13
Error 309 – GVW > 280 kips (check outcome)
Error 325 – Any Axle Spacing < 3.4 ft
Error 344 – GVW > +/- 7% of the Sum of the Axle Weights

Quality Control Checks for Processing WIM Data

The method used to clean, filter, and sort the raw WIM data includes the following tasks:

- Obtain raw WIM data from ODOT ftp site.
- Identify format errors in raw WIM data and reformat for subsequent processing (program Wingnut#.exe where # is the current version number).
- Identify WIM record errors (program Liger#.exe where # is the current version number).
- Review error files to ensure reported errors are captured and no records are lost.
- Sort data into weight-table classifications (program Tablesorter#.exe where # is the current version number).
- Filter records containing 3S2 configurations and compiles the T2PCTP and T3MCTP records (program 3S2_Nubs2b).
- Spot check records to ensure proper sort.
- Plot GVW results to look for visual distinctions such as repeated records, spurious outliers, and other inconsistencies. It was observed that the cleaned and sorted records could contain replicate identical records, of which only one was true. This visual scanning of results is still necessary and it is not recommended to use a purely computerized process.
- Import weight-table records into Excel and sort top 20%.

As part of the data evaluation process, a series of quality control checks were performed to verify the accuracy of the data classification performed by OSU. The QC process included the following:

- Verification of WIM data record error identification.
- Verification of raw WIM record transcription to OSU usable format.
- Verification of sorting algorithm for weight-table classification.

All software programs written by OSU that were used for cleaning and sorting the raw WIM data were independently checked. The software programs were verified by creating sample input files for each step of the cleaning and sorting process. These sample input files contained each of the specific error identification types that were to be captured, as well as specific valid WIM records that were of known classification.

1. Raw WIM data are used for input into Wingnut#.exe for initial sorting. Eleven (11) errors are identified and removed by this program. Primarily errors at this stage are format issues. Data with formatting errors are removed and placed in error files. To check the program, a sample input file was made with over 50 entries. Some entries were valid WIM records and others included the specific errors to be found and omitted from the data set at this point. The order of the valid data and known errors were random. The output results from Wingnut# were checked against the errors that were intended. All errors were correctly

identified with the exception of Error 325 which only pertains to the old style WIM files with axle pictograms and as such not included in the sample file.

Error 144 – If line1(N:N+4).EQ.'W 0.0' (TYPE)

Error 184 – If line1(N:N+3).NE.'LANE' (TYPE)

Error 203 – If line1(N:N+4).EQ.'W 0.0' (CLASS)

Error 244 – If line1(N:N+3).NE.'LANE' (CLASS)

Error 253 – If line1(N:N+1).EQ.'TY'.OR.line1(N:N).EQ.'C' is not true

Error 275 – If line2(N:N).EQ.'U'

Error 300 – If line2(N:N).NE.'k' (18-K)

Error 327 – If line2(N:N).NE.'k' (ESAL)

Error 361 – If line3(N:N+3).EQ.'AXLE'.OR.'18-K'.OR.'ESAL'

Error 377 – If line4(N:N+3).EQ.'(ft)'

Error 325 – If line8(N:N+1).EQ.'Un'

2. The next step in the sorting process is program Liger#.exe. There are 14 errors identified and removed by this program. These are errors that identify outlier data that typically would be an erroneous record. Using the sample input file with specified errors and valid data, all the error types were properly captured and stored in the error files. The only issue that was detected was for speeds greater than 99 mph. The program read only 2 integers and so did not catch those trucks that might be traveling over 100 mph. This was corrected and

subsequently verified. There was no impact on the prior load factor results based on this format specification, particularly as the WIM system already identifies vehicles that are traveling too fast and does not record the data for such cases.

Error 142 – Invalid Date ((15:15) does not equal ':' and (25:27) does not equal '200')
Error 165 – Non-Numerical Value (char. 28 - 222 contains a non-numerical value)
Error 177 – Decimal Value in Wrong Place
Error 202 – Individual Axle Weight > 50 kips
Error 216 – Speed < 10 mph
Error 229 – Speed > 99 mph
Error 242 – Length > 200 ft
Error 256 – Bumper-to-Bumper Length + 10 ft < The Sum of the Axle Spacings
Error 269 – Length < 7 ft AND Sum of Axles < 7 ft
Error 282 – 1st Axle Spacing < 5 ft (steer axle)
Error 296 – Axle # does not Equal 1 - 13
Error 309 – GVW > 280 kips (check outcome)
Error 325 – Any Axle Spacing < 3.4 ft
Error 344 – GVW > +/- 7% of the Sum of the Axle Weights

3. The weight-table sort is performed with two FORTRAN programs that use the Liger cleaned WIM data. The data are sorted into the correct ODOT permit weight-table classifications. To verify this program, an input file was made that included 3 trucks from each of the weight tables (Tables 1 through 5). The three record examples for each table classification were taken from the lower, the middle, and the upper range of each table. The data were properly sorted by overall GVW into the correct weight tables.

4. The second program that sorts the cleaned truck data is 3S2_Nubs.exe. This program sorts the Liger data into 3S2's and T2PCTP (Table 2 with continuous trip permit trucks) and T3MCTP (Table 3 without the continuous permit trucks) folders for input into load factor statistics. A day in a month was run in this program to verify that all trucks sorted into 3S2 were 5 axles and met the axle spacing requirements for the 3S2. The spacing used was the default (>5.5'). The program correctly identified the 5 axle vehicles and these were further correctly sorted out into the 3S2 configurations.

   Next, the T2PCTP and T3MCTP were verified against the output tables from table sorter. The Table 3 file was sorted by axles and then axle spacing to identify the 3S2 trucks and to verify the final number of these trucks matched those subtracted from the new T3MCTP file and the same number was added to T2PCTP (except for those vehicles with GVW > 80 kips).

The WIM data processing described above relies on specific data formatting. If the format is changed in the future, the programs will need to be updated. Additionally, the permit weight table sort used by OSU is based on the current ODOT permit weight tables: STK#300557 (Permit Weight Table 1), STK#300558 (Permit Weight Table 2), STK#300559 (Permit Weight Table 3), STK#300560 (Permit Weight Table 4), STK#300561 (Permit Weight Table 5). If these permit tables change, then the program Tablesorter will need to be revised accordingly.

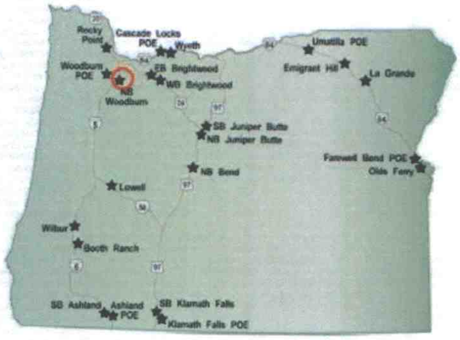
To ensure changes can be properly implemented, ODOT should inform OSU of future changes when or if they occur.

APPENDIX C

Interstate 5

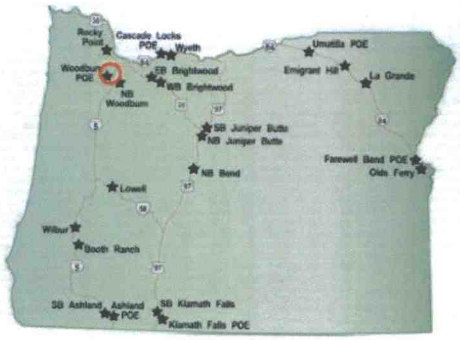
Woodburn NB

Location (MP)	I-5 (274.15)
ADT	41,893
ADTT	5,550
# Lanes	3
# Lanes Instrumented	2
WIM Equipment	Single Load Cell
Date of Last Calibration	June 05
Calibration Interval	6 mths. (or as needed)



Woodburn POE SB

Location (MP)	I-5 (274.18)
ADT	44,748
ADTT	5,689
# Lanes	3
# Lanes Instrumented	2
WIM Equipment	Single Load Cell
Date of Last Calibration	June 05
Calibration Interval	6 mths. (or as needed)



Wilbur SB

Location (MP)	130.03
ADT	19,244
ADTT	2,602
# Lanes	2
# Lanes Instrumented	2
WIM Equipment	Single Load Cell
Date of Last Calibration	Sept. 05
Calibration Interval	6 mths. (or as needed)

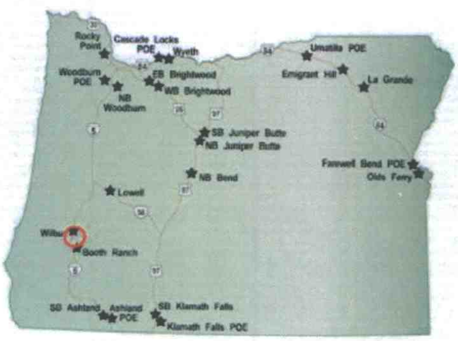
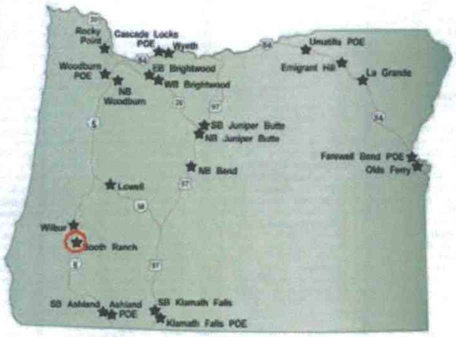


Figure C3.1: Oregon WIM site data and locations.

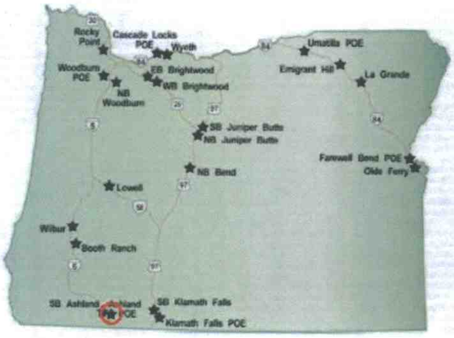
<u>Booth Ranch NB</u>

Location (MP)	111.07
ADT	12,619
ADTT	3,442
# Lanes	2
# Lanes Instrumented	1
WIM Equipment	Single Load Cell
Date of Last Calibration	Aug 05
Calibration Interval	6 mths. (or as needed)



<u>Ashland POE NB</u>

Location (MP)	18.08
ADT	11,710
ADTT	2,979
# Lanes	2
# Lanes Instrumented	1
WIM Equipment	Single Load Cell
Date of Last Calibration	Dec 05
Calibration Interval	6 mths. (or as needed)



<u>Ashland SB</u>

Location (MP)	18.24
ADT	11,776
ADTT	2,838
# Lanes	2
# Lanes Instrumented	1
WIM Equipment	Single Load Cell
Date of Last Calibration	Dec 05
Calibration Interval	6 mths. (or as needed)

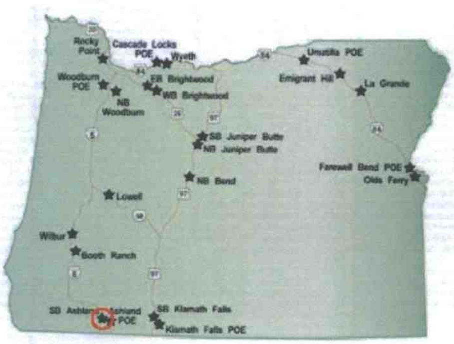
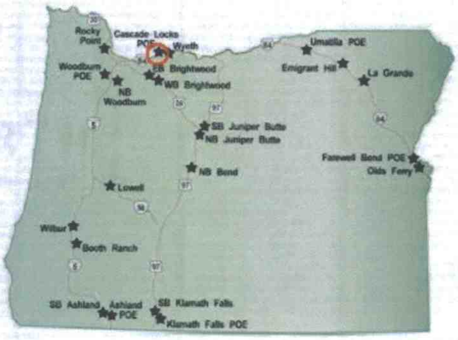


Figure C3.1 (Continued): Oregon WIM site data and locations.

Interstate 84

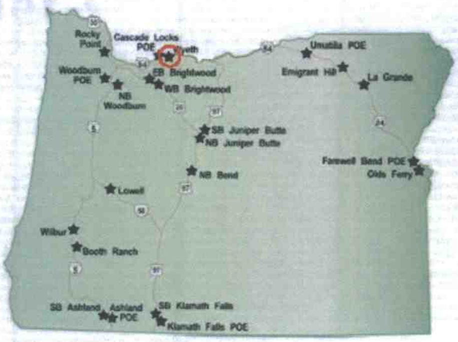
Cascade Locks POE EB

Location (MP)	44.93
ADT	9,880
ADTT	4,602
# Lanes	2
# Lanes Instrumented	1
WIM Equipment	Single Load Cell
Date of Last Calibration	Sept 05
Calibration Interval	6 mths. (or as needed)



Wyeth WB

Location (MP)	54.30
ADT	7011
ADTT	2,158
# Lanes	2
# Lanes Instrumented	2
WIM Equipment	Single Load Cell
Date of Last Calibration	Oct 05
Calibration Interval	6 mths. (or as needed)



Emigrant Hill WB

Location (MP)	226.95
ADT	3,252
ADTT	1,786
# Lanes	2
# Lanes Instrumented	1
WIM Equipment	Single Load Cell
Date of Last Calibration	Oct 05
Calibration Interval	6 mths. (or as needed)

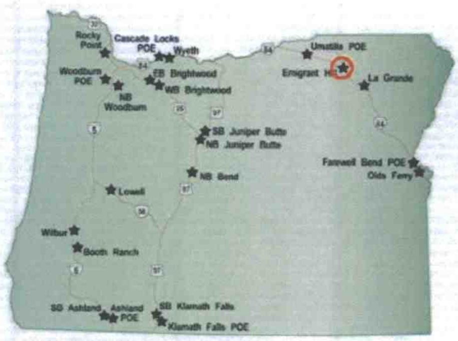
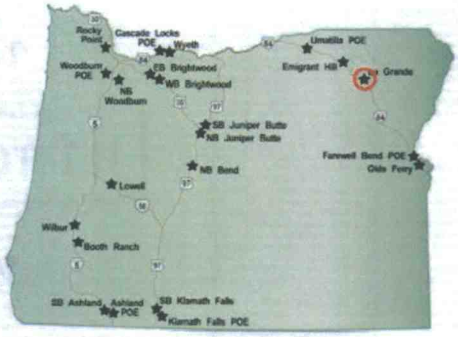


Figure C3.1 (Continued): Oregon WIM site data and locations.

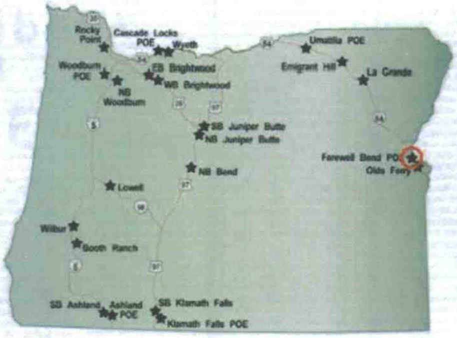
<u>La Grande EB</u>

Location (MP)	258.52
ADT	3,972
ADTT	2,327
# Lanes	2
# Lanes Instrumented	1
WIM Equipment	Single Load Cell
Date of Last Calibration	Sept 05
Calibration Interval	6 mths. (or as needed)



<u>Farewell Bend POE WB</u>

Location (MP)	353.31
ADT	2,866
ADTT	1,848
# Lanes	2
# Lanes Instrumented	1
WIM Equipment	Single Load Cell
Date of Last Calibration	Sept 05
Calibration Interval	6 mths. (or as needed)



<u>Olds Ferry EB</u>

Location (MP)	354.38
ADT	3,458
ADTT	2,045
# Lanes	2
# Lanes Instrumented	1
WIM Equipment	Single Load Cell
Date of Last Calibration	Sept 05
Calibration Interval	6 mths. (or as needed)

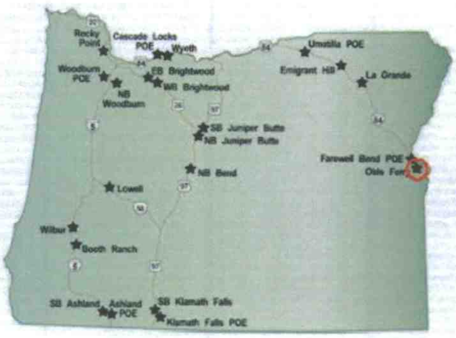
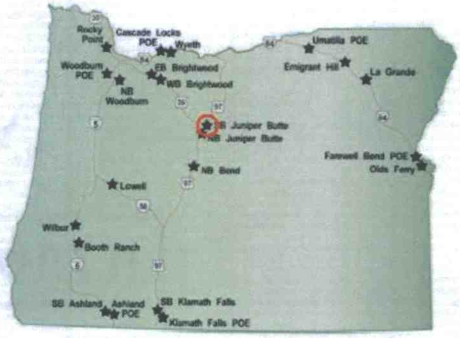


Figure C3.1 (Continued): Oregon WIM site data and locations.

US Highway 97

Juniper Butte SB	
Location (MP)	108.20
ADT	4,967
ADTT	935
# Lanes	2
# Lanes Instrumented	1
WIM Equipment	Single Load Cell
Date of Last Calibration	Nov 05
Calibration Interval	6 mths. (or as needed)



Juniper Butte NB	
Location (MP)	106.90
ADT	4,792
ADTT	882
# Lanes	2
# Lanes Instrumented	1
WIM Equipment	Single Load Cell
Date of Last Calibration	Nov 05
Calibration Interval	6 mths. (or as needed)

Bend NB	
Location (MP)	145.50
ADT	6,943
ADTT	607
# Lanes	2
# Lanes Instrumented	1
WIM Equipment	Single Load Cell
Date of Last Calibration	Oct 05
Calibration Interval	6 mths. (or as needed)

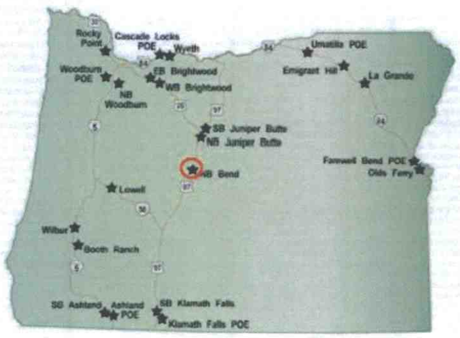
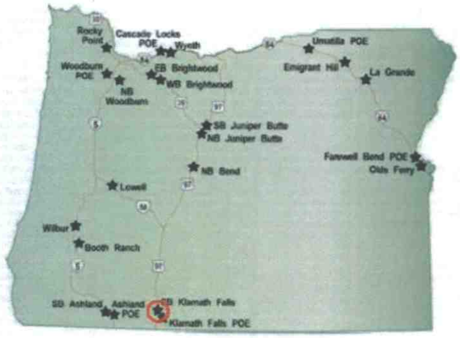


Figure C3.1 (Continued): Oregon WIM site data and locations.

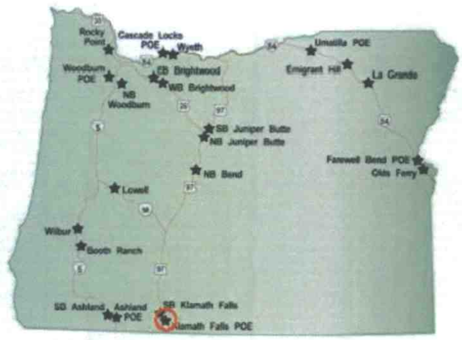
Klamath Falls SB

Location (MP)	271.41
ADT	3,129
ADTT	907
# Lanes	2
# Lanes Instrumented	1
WIM Equipment	Single Load Cell
Date of Last Calibration	Oct 05
Calibration Interval	6 mths. (or as needed)



Klamath Falls POE NB

Location (MP)	271.73
ADT	3,857
ADTT	769
# Lanes	2
# Lanes Instrumented	1
WIM Equipment	Single Load Cell
Date of Last Calibration	Oct 05
Calibration Interval	6 mths. (or as needed)



OR Highway 58

Lowell WB

Location (MP)	17.17
ADT	3,205
ADTT	581
# Lanes	2
# Lanes Instrumented	1
WIM Equipment	Single Load Cell
Date of Last Calibration	Nov 05
Calibration Interval	6 mths. (or as needed)

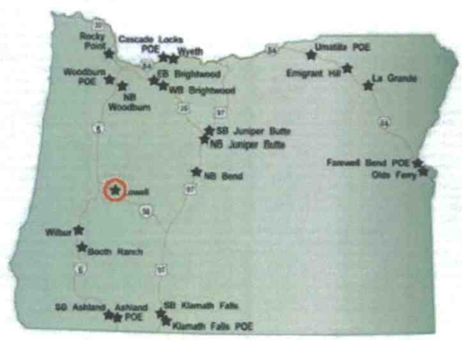
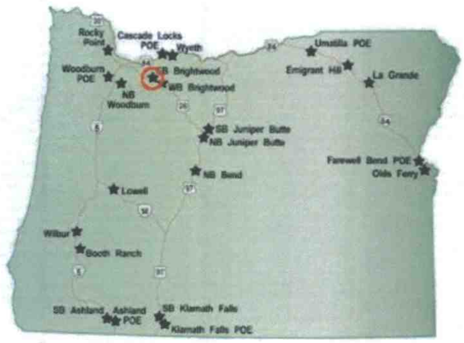


Figure C3.1 (Continued): Oregon WIM site data and locations.

US Highway 26

<u>Brightwood EB</u>

Location (MP)	36.51
ADT	4,761
ADTT	357
# Lanes	2
# Lanes Instrumented	1
WIM Equipment	Single Load Cell
Date of Last Calibration	Sept 05
Calibration Interval	6 mths. (or as needed)



<u>Brightwood WB</u>

Location (MP)	36.31
ADT	4,360
ADTT	787
# Lanes	2
# Lanes Instrumented	1
WIM Equipment	Single Load Cell
Date of Last Calibration	Sept 05
Calibration Interval	6 mths. (or as needed)

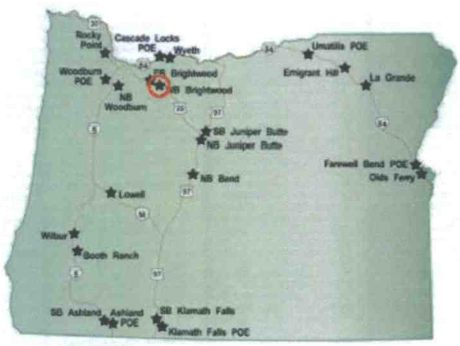


Figure C3.1 (Continued): Oregon WIM site data and locations.

APPENDIX D

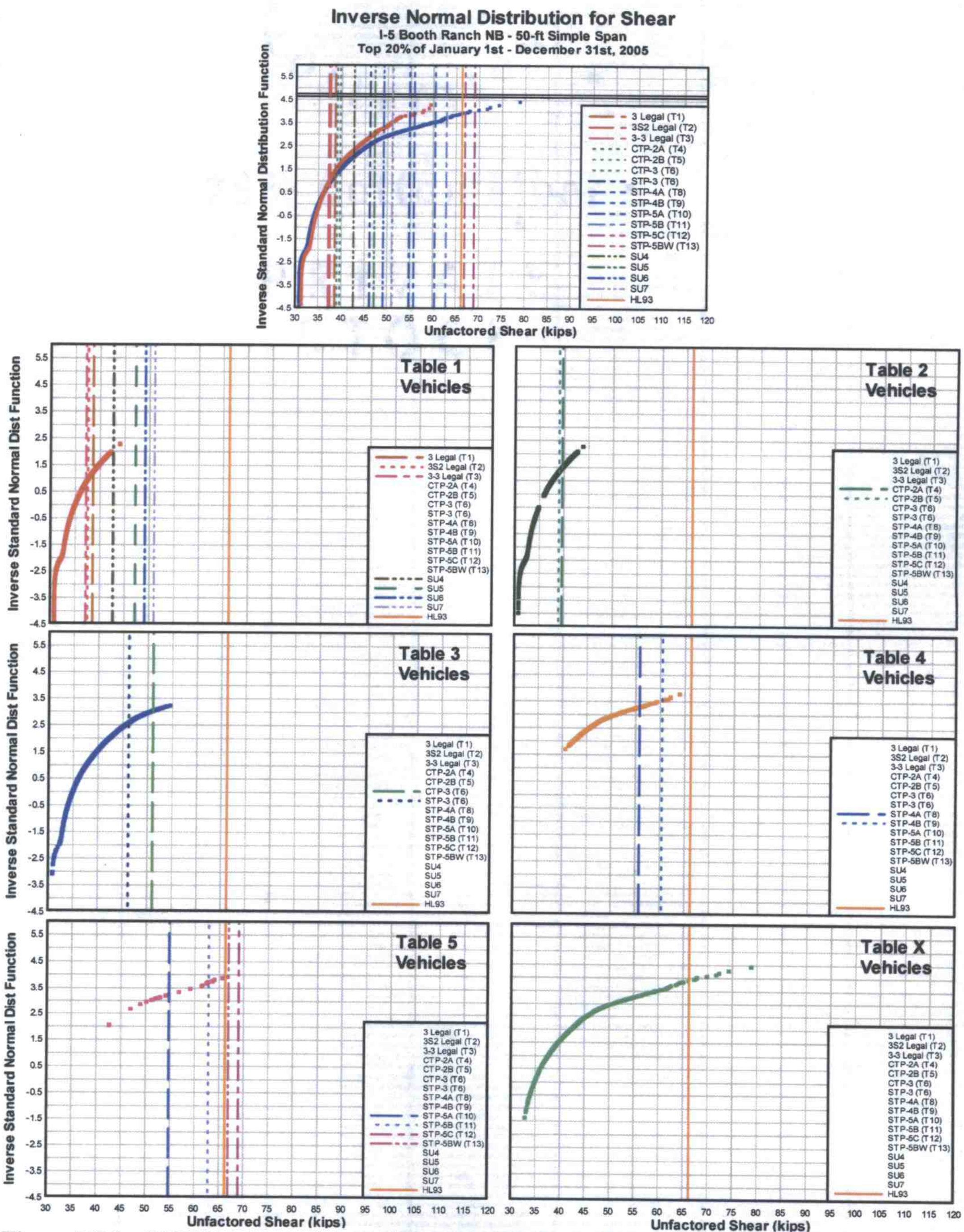


Figure D3.1: CDF plots for unfactored shear for 50-ft simple span bridge model.

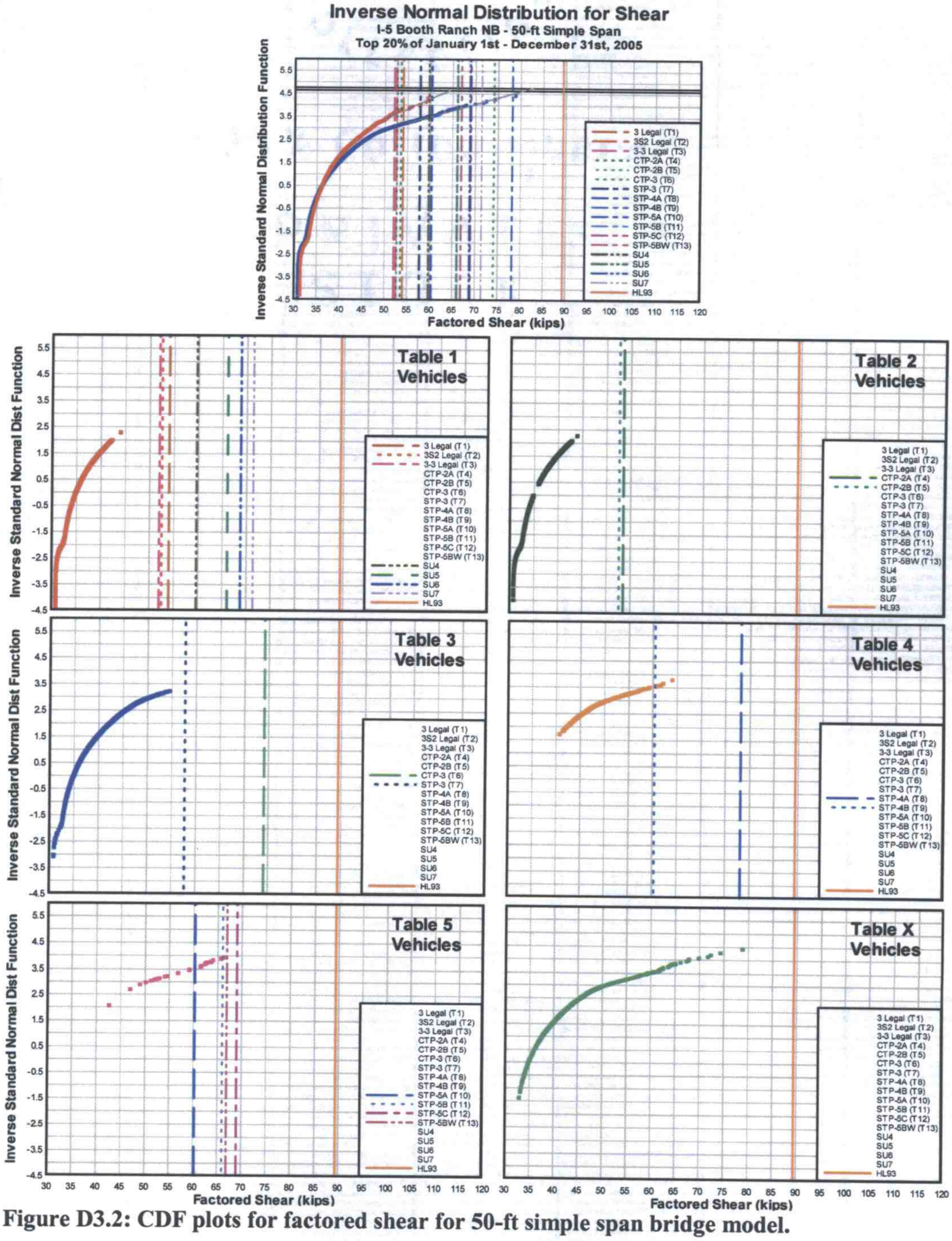


Figure D3.2: CDF plots for factored shear for 50-ft simple span bridge model.

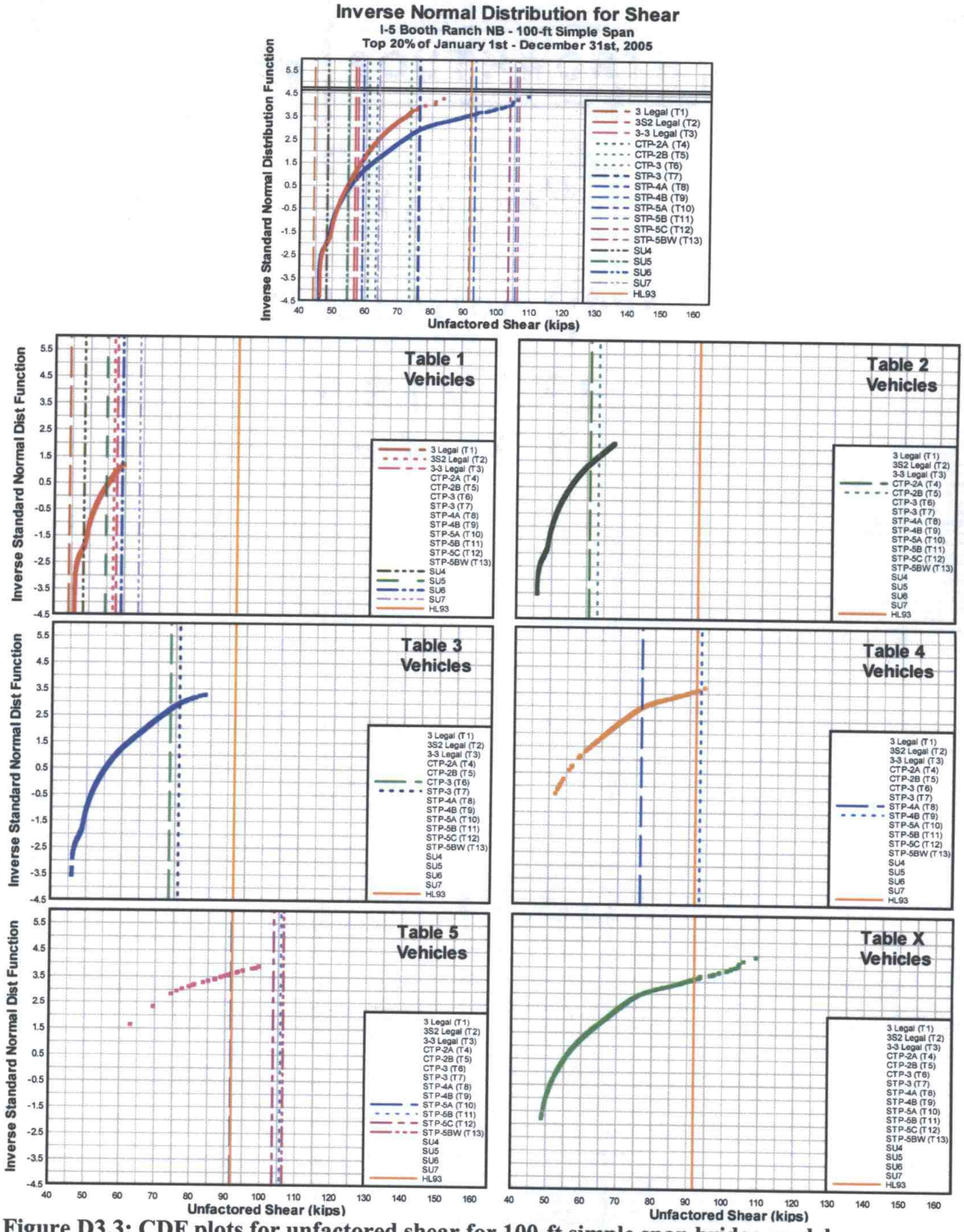


Figure D3.3: CDF plots for unfactored shear for 100-ft simple span bridge model.

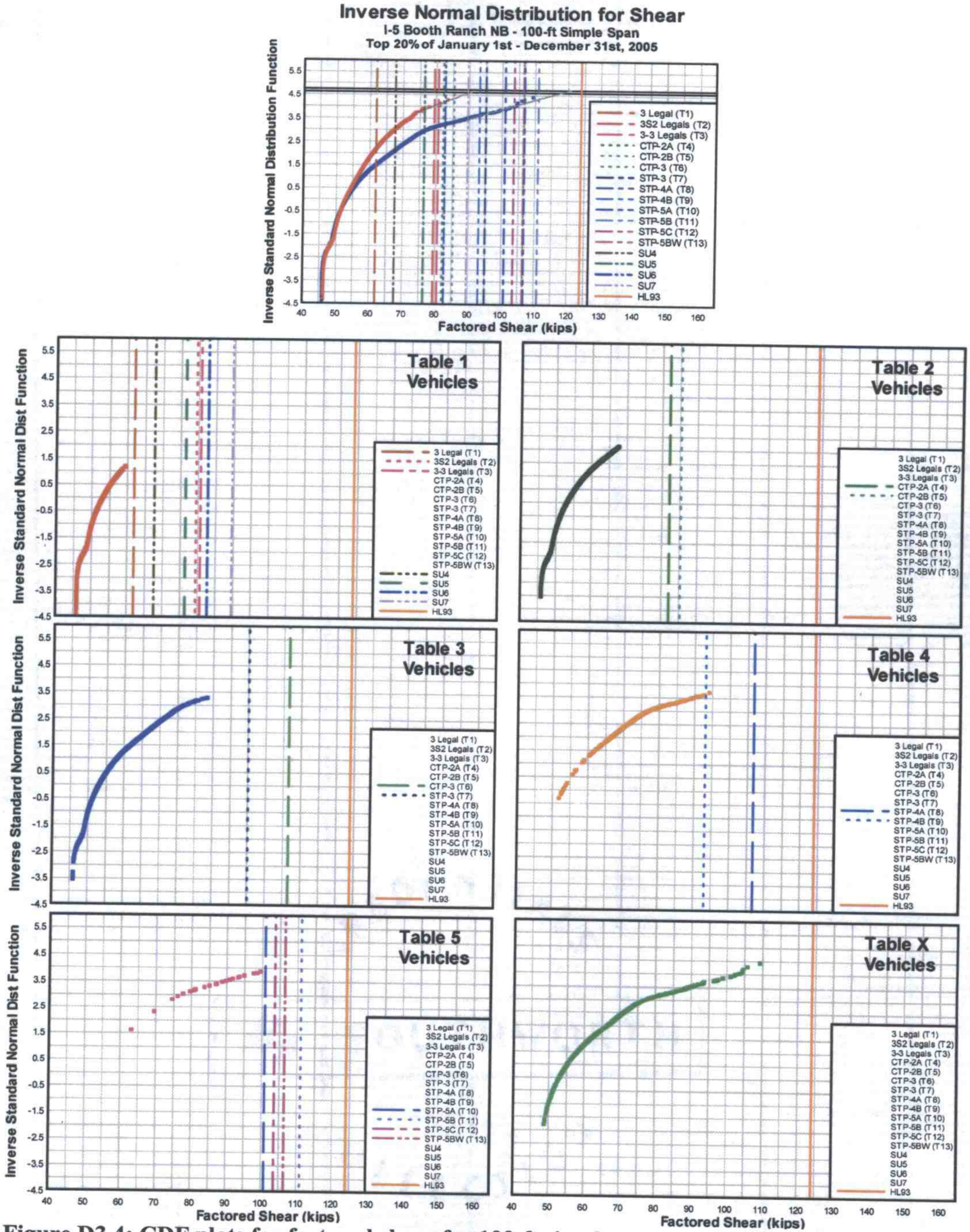


Figure D3.4: CDF plots for factored shear for 100-ft simple span bridge model.

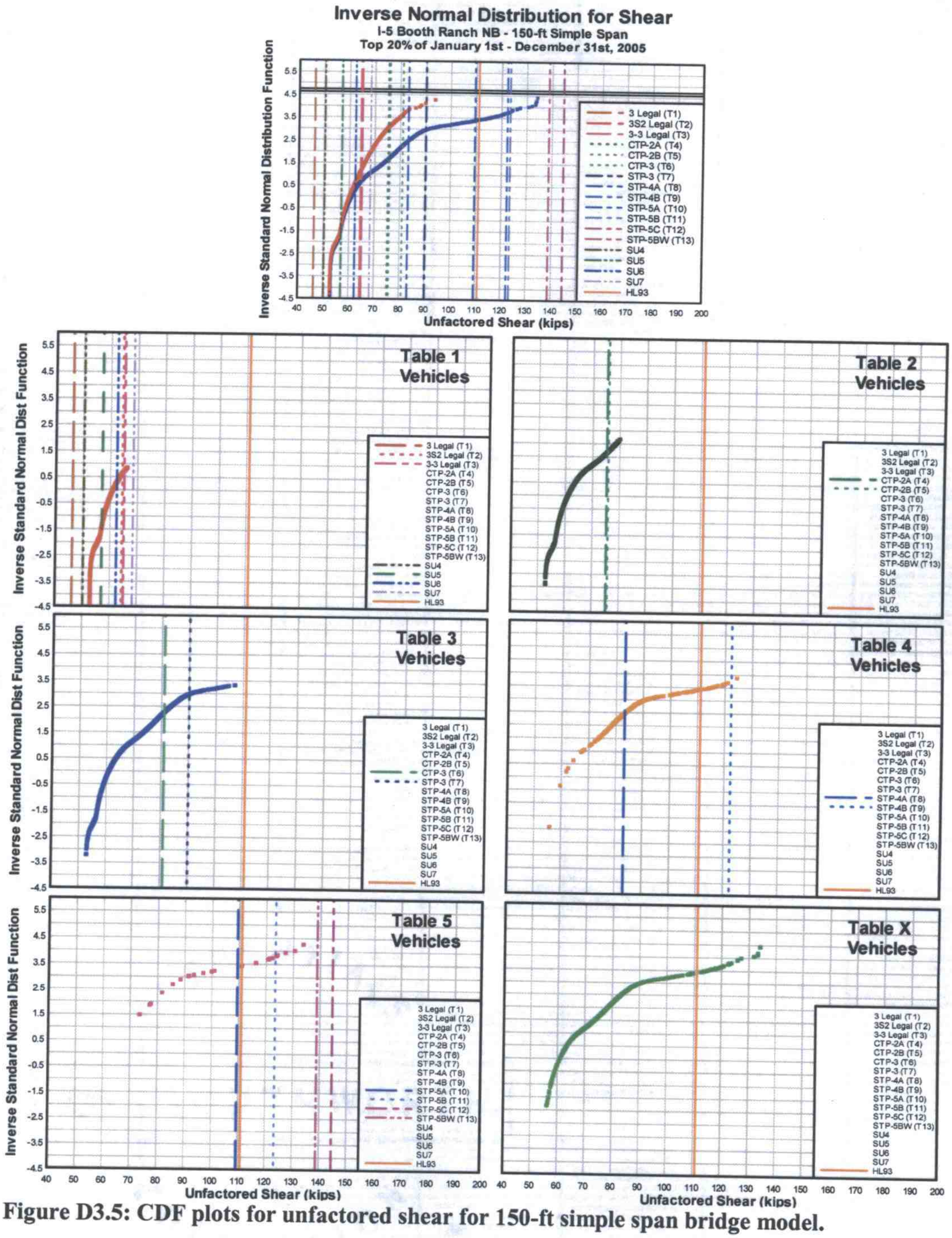


Figure D3.5: CDF plots for unfactored shear for 150-ft simple span bridge model.

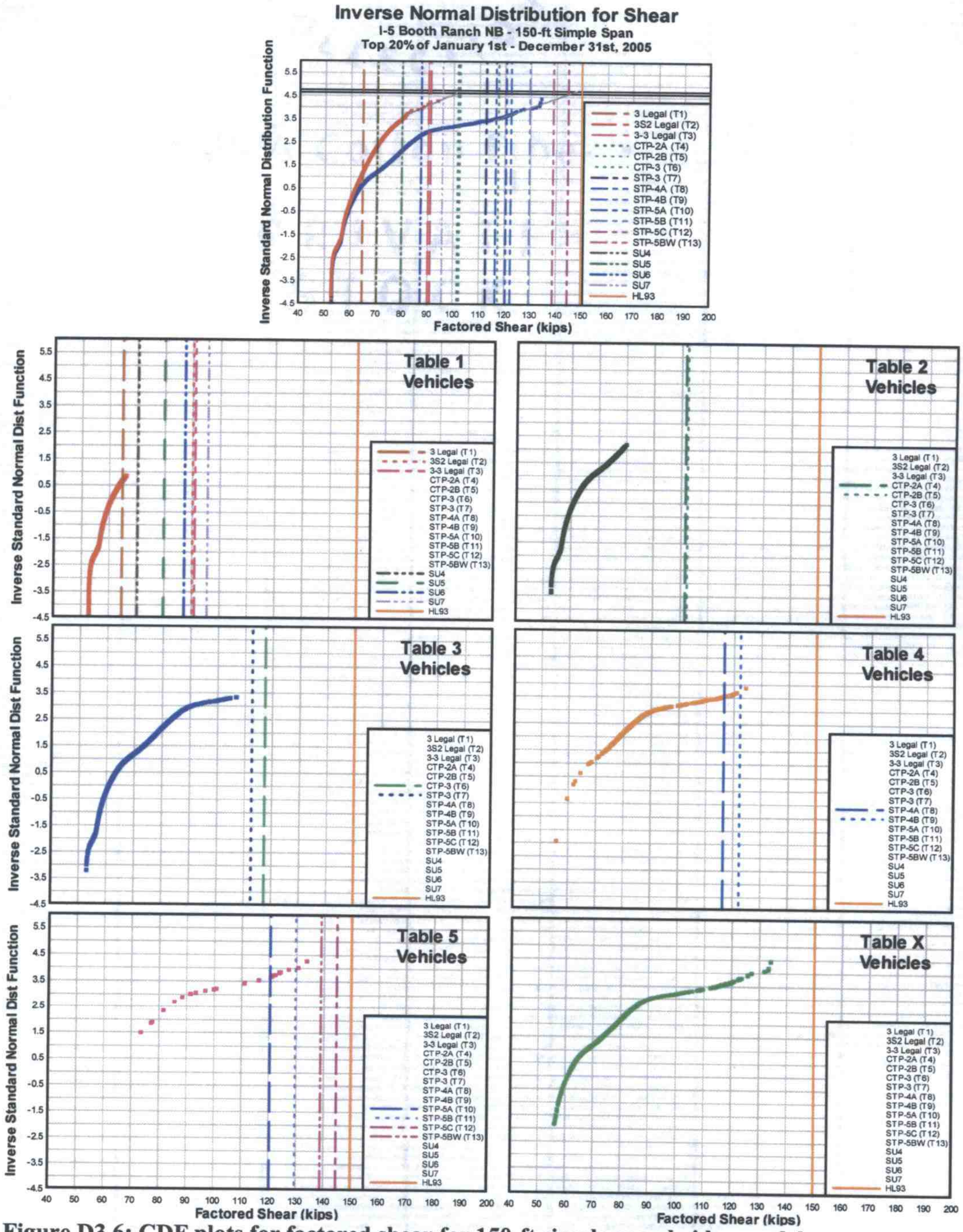


Figure D3.6: CDF plots for factored shear for 150-ft simple span bridge model.

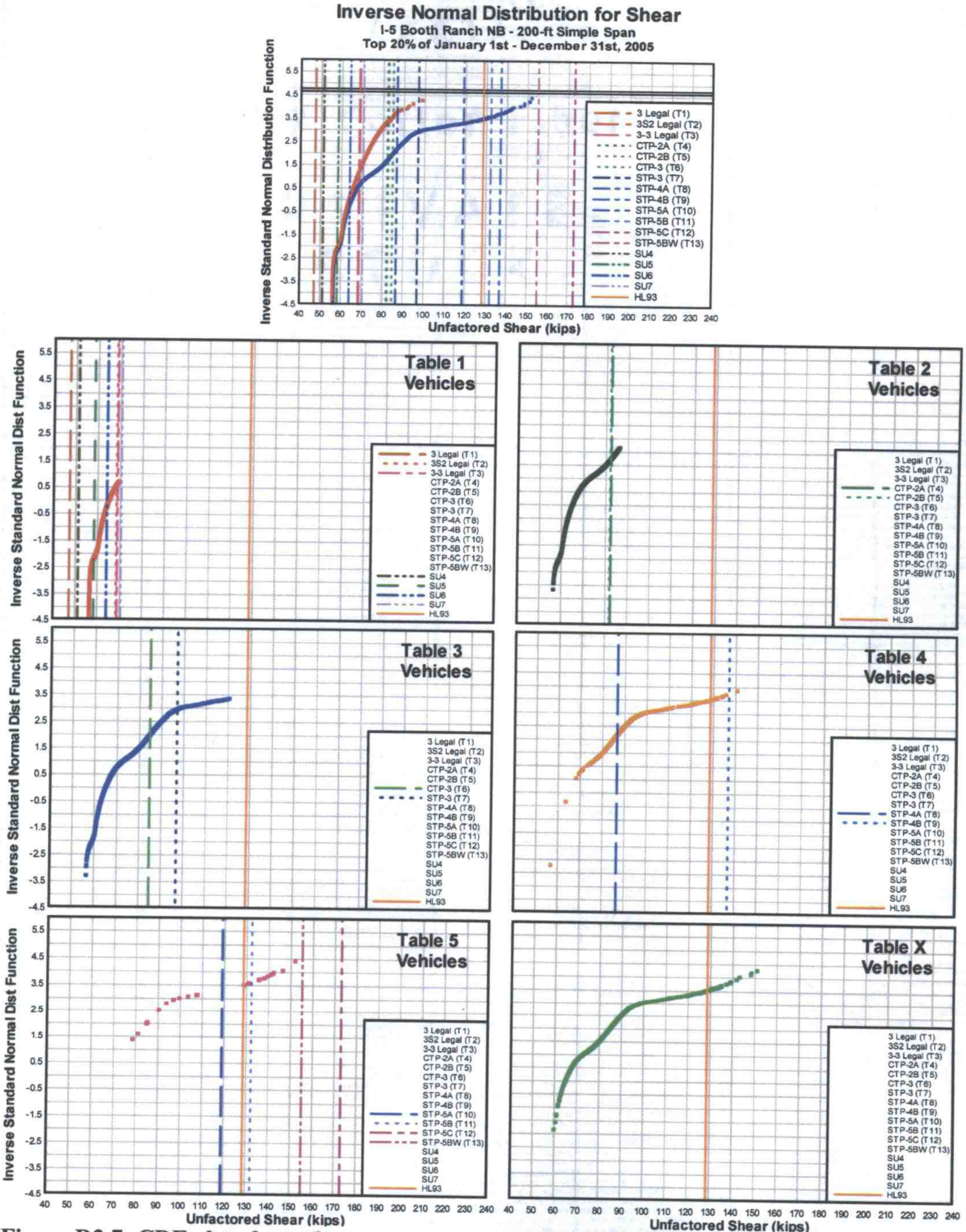


Figure D3.7: CDF plots for unfactored shear for 200-ft simple span bridge model.

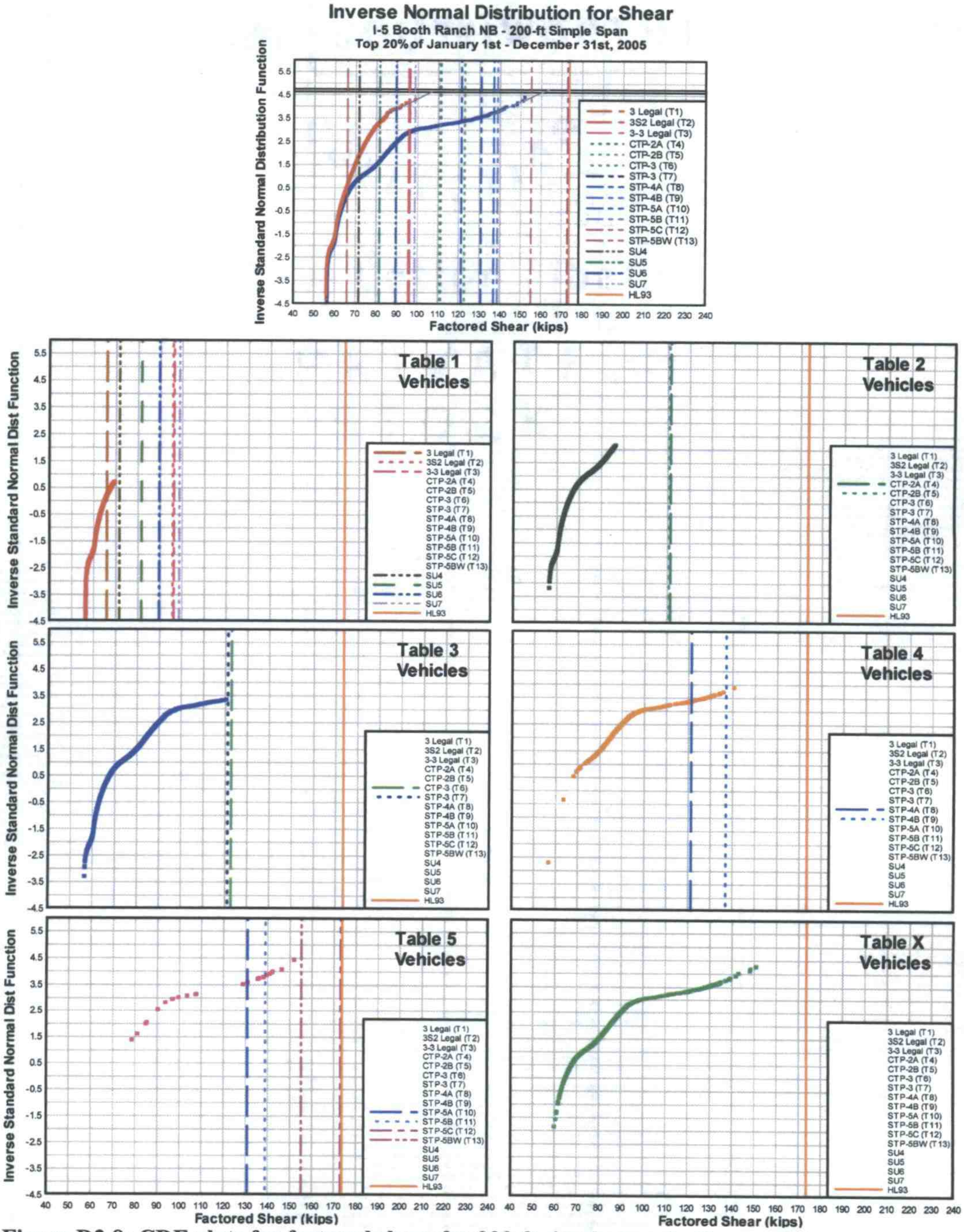


Figure D3.8: CDF plots for factored shear for 200-ft simple span bridge model.

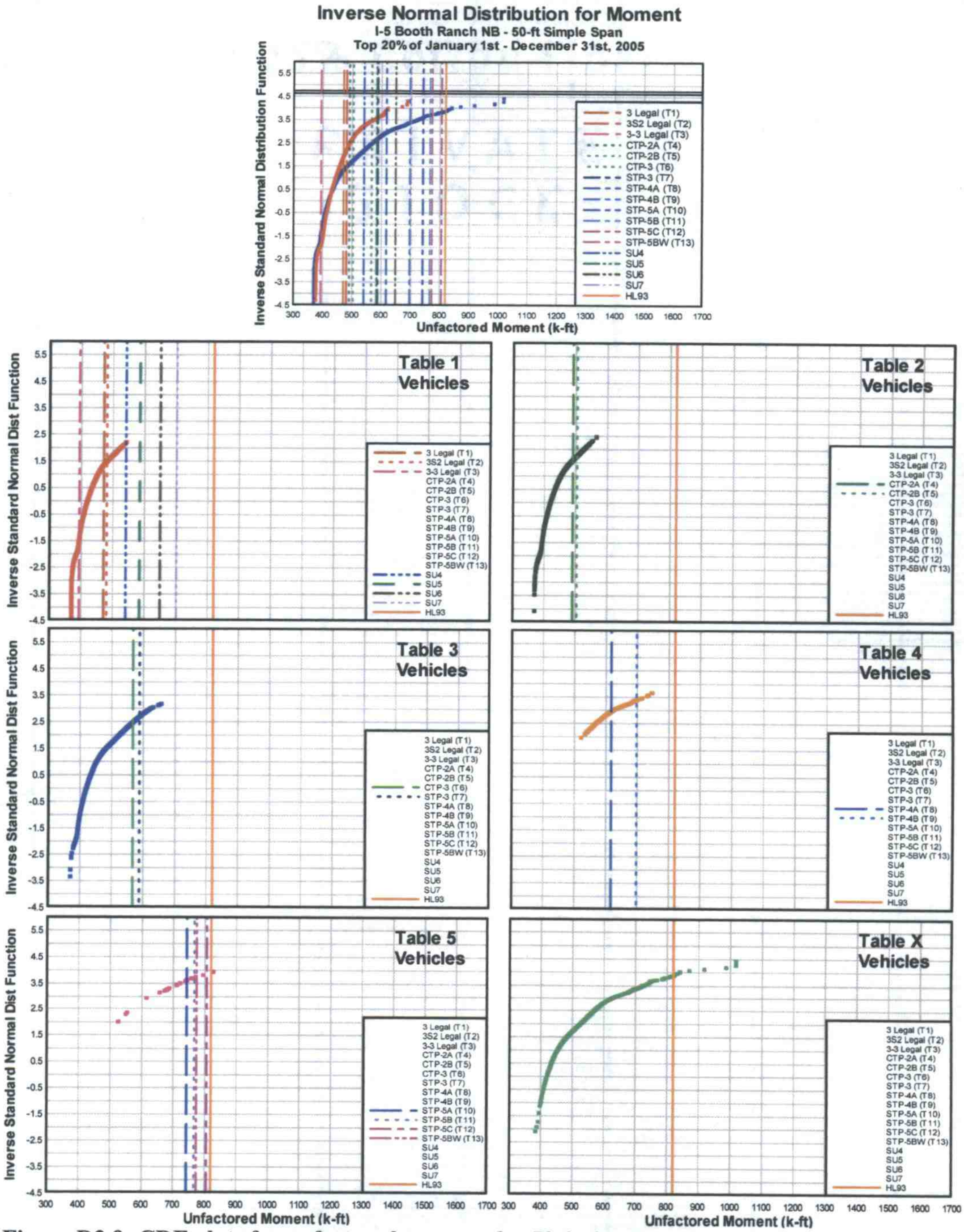


Figure D3.9: CDF plots for unfactored moment for 50-ft simple span bridge model.

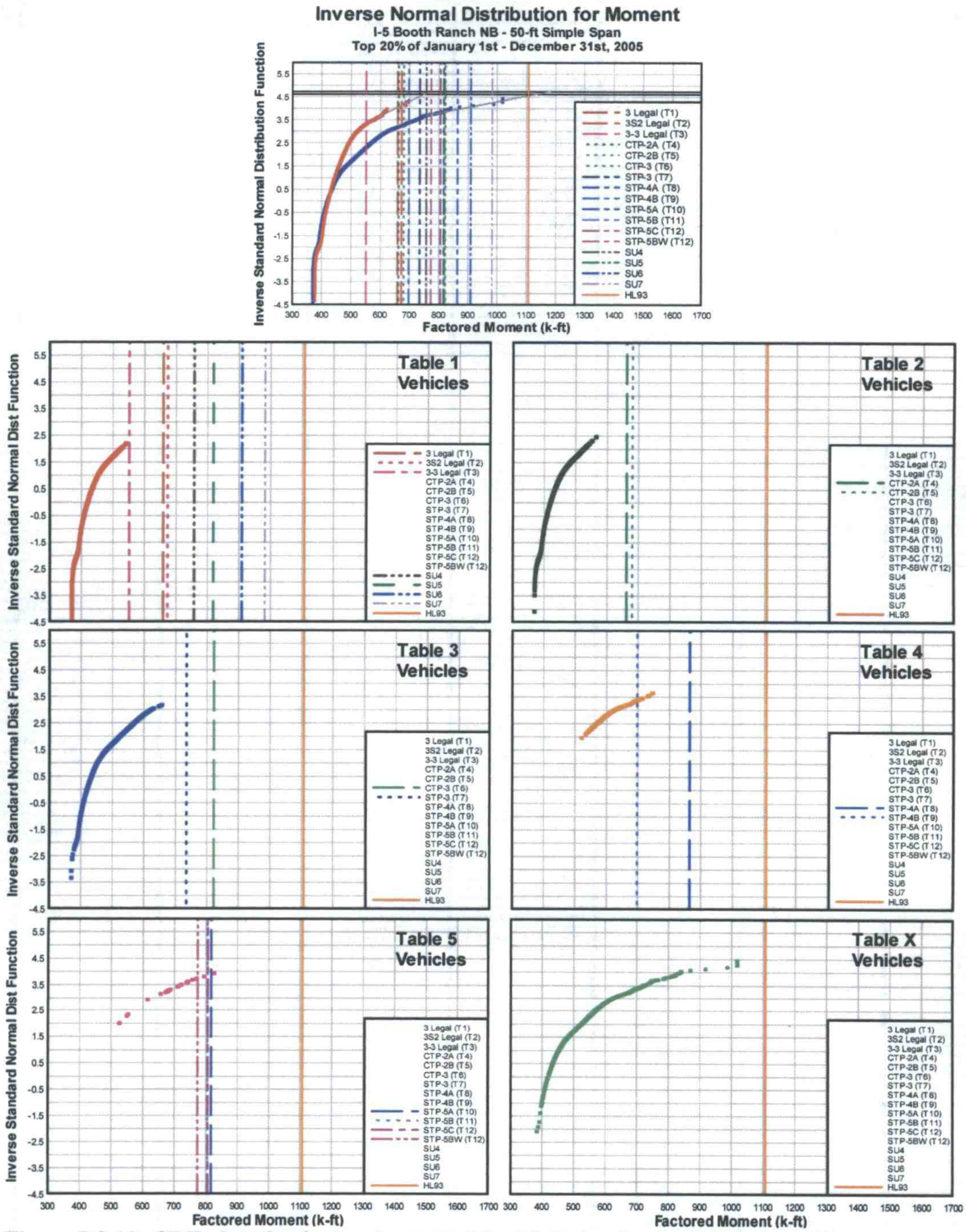


Figure D3.10: CDF plots for factored moment for 50-ft simple span bridge model.

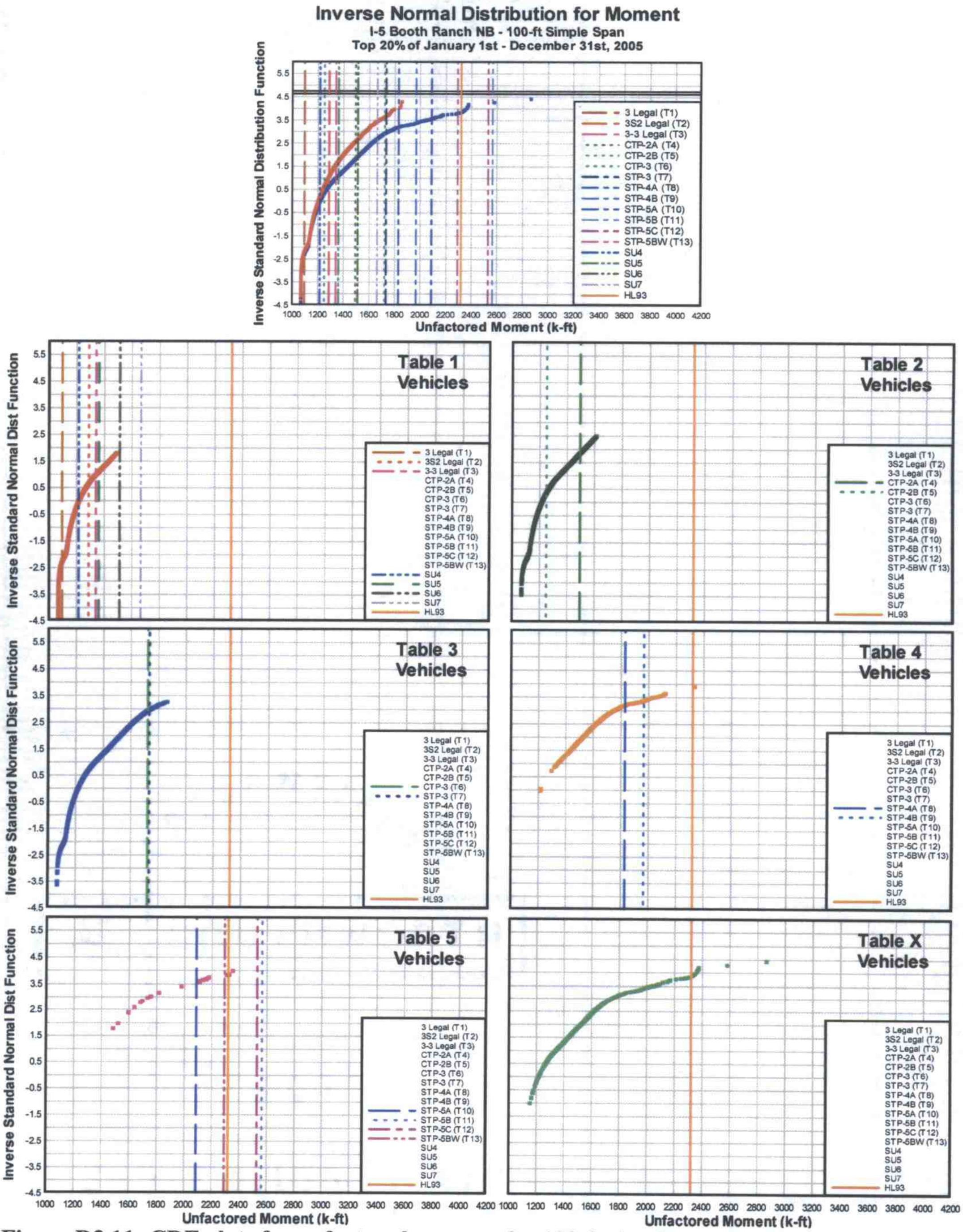


Figure D3.11: CDF plots for unfactored moment for 100-ft simple span bridge model.

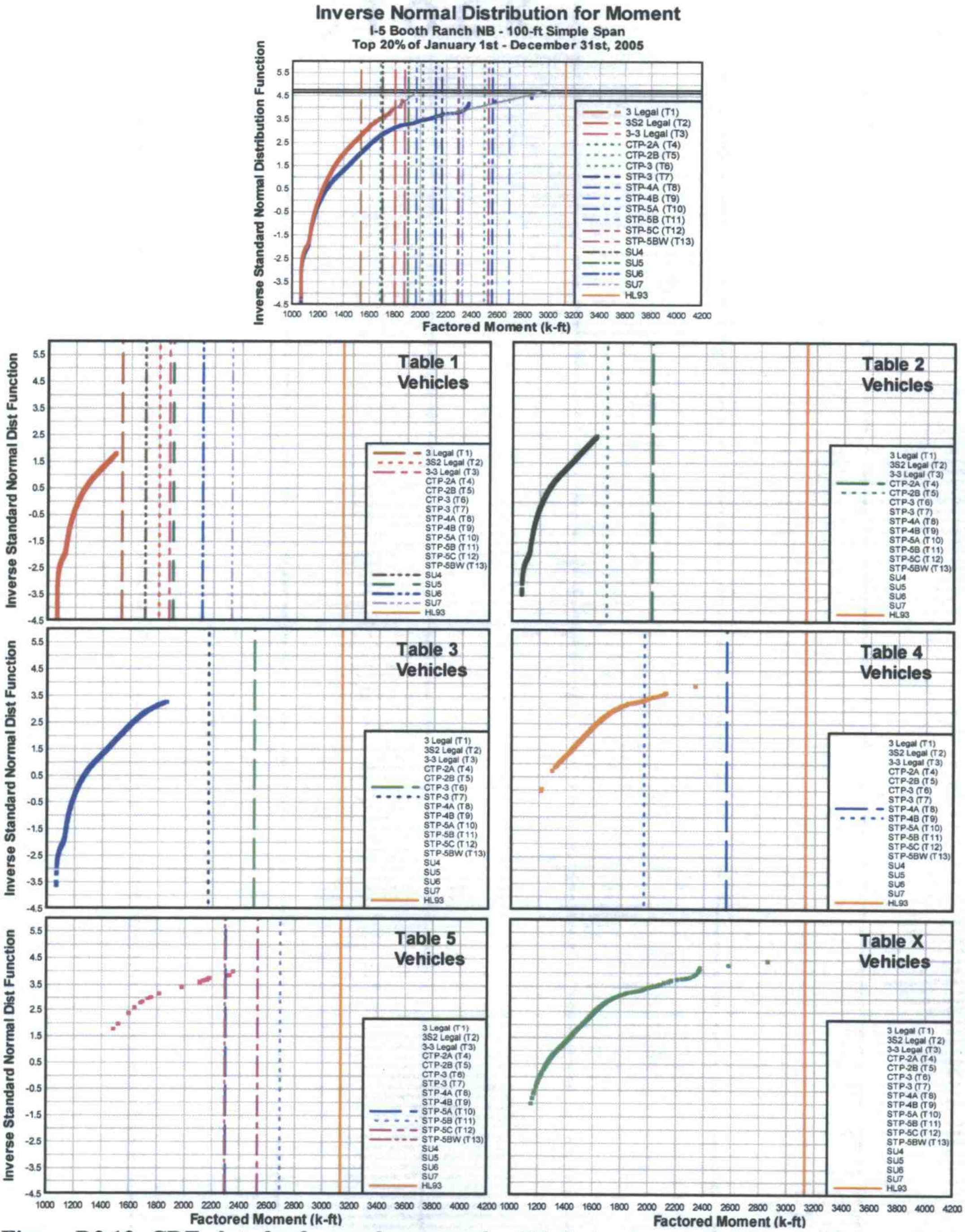


Figure D3.12: CDF plots for factored moment for 100-ft simple span bridge model.

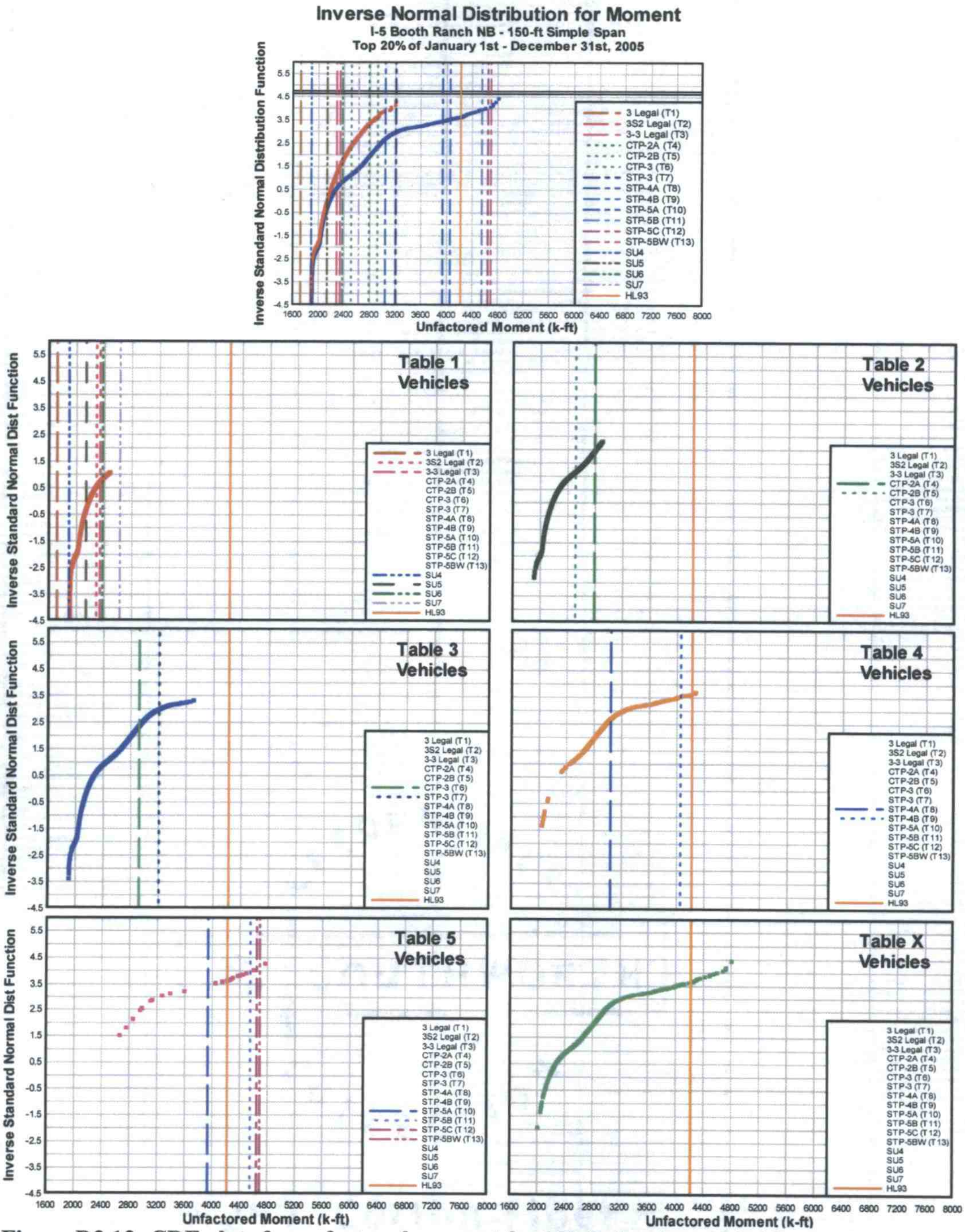


Figure D3.13: CDF plots for unfactored moment for 150-ft simple span bridge model.

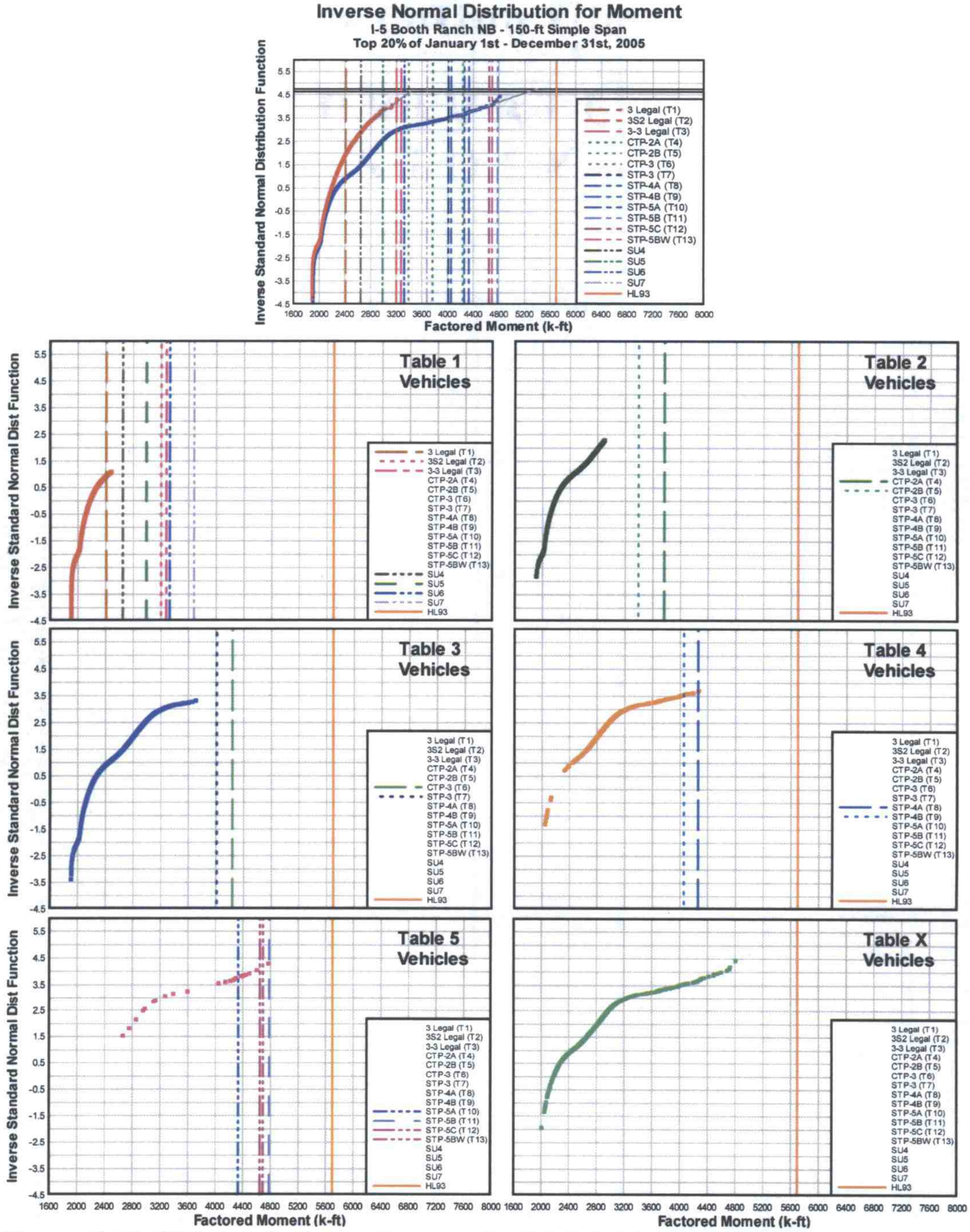


Figure D3.14: CDF plots for factored moment for 150-ft simple span bridge model.

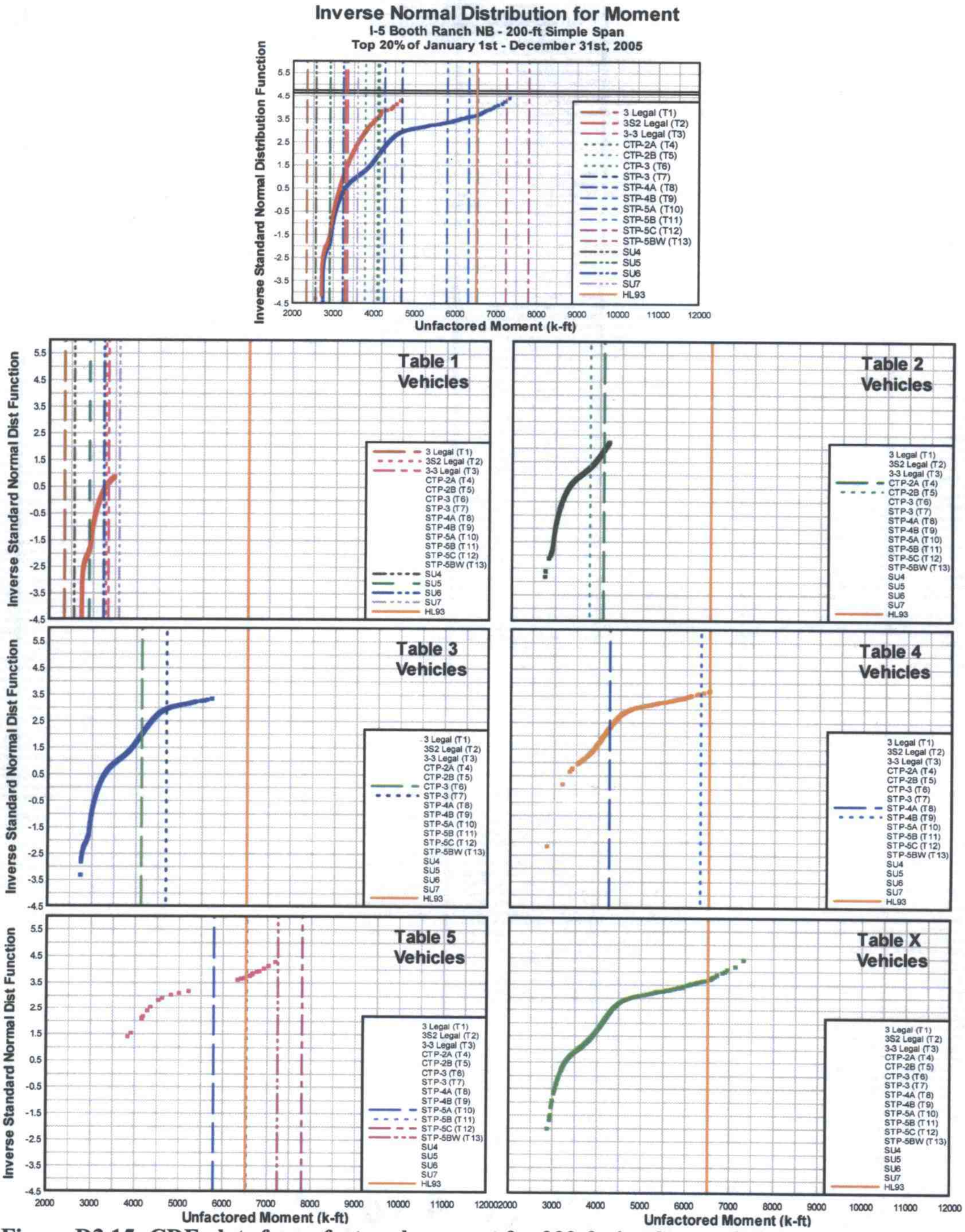


Figure D3.15: CDF plots for unfactored moment for 200-ft simple span bridge model.

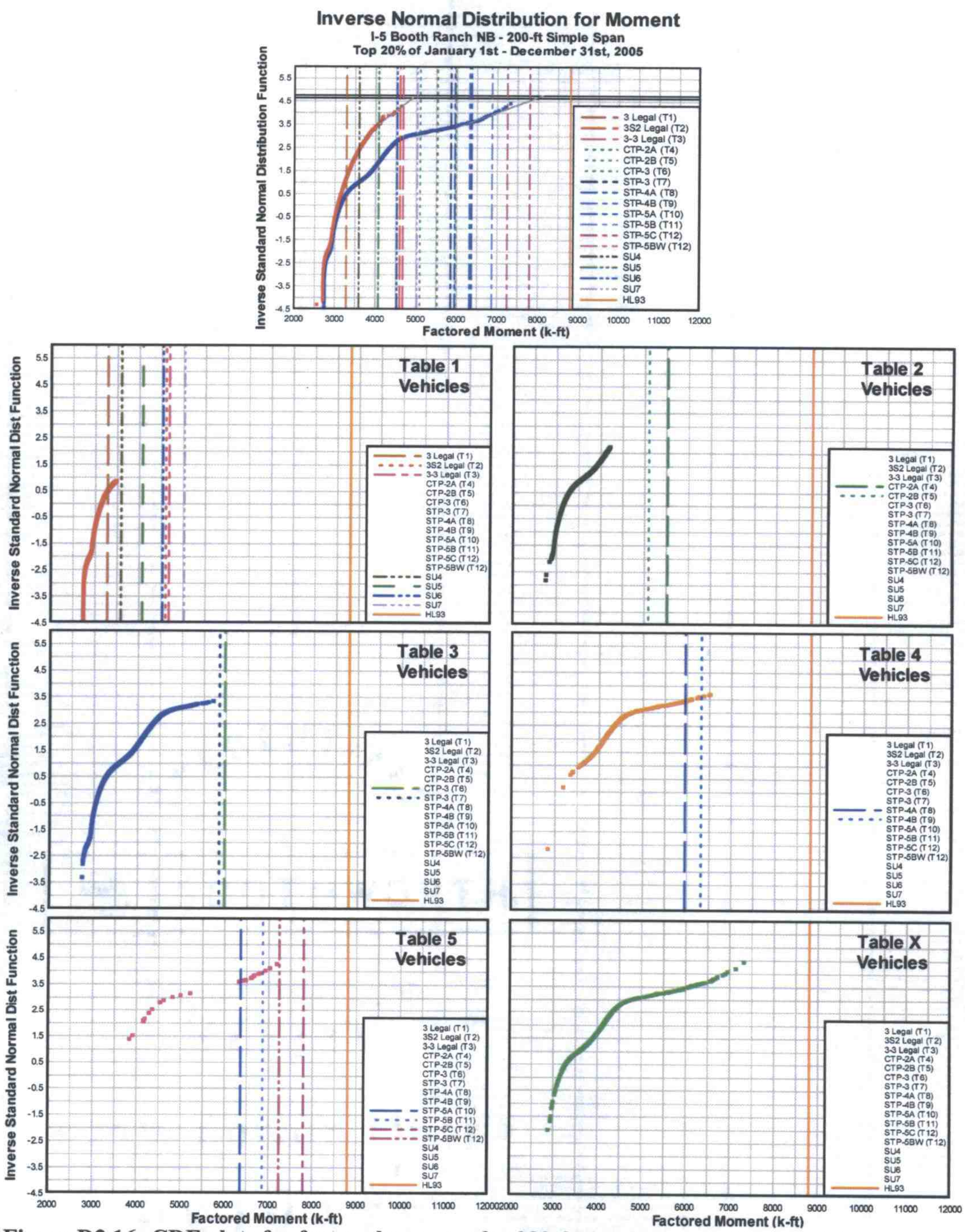


Figure D3.16: CDF plots for factored moment for 200-ft simple span bridge model.

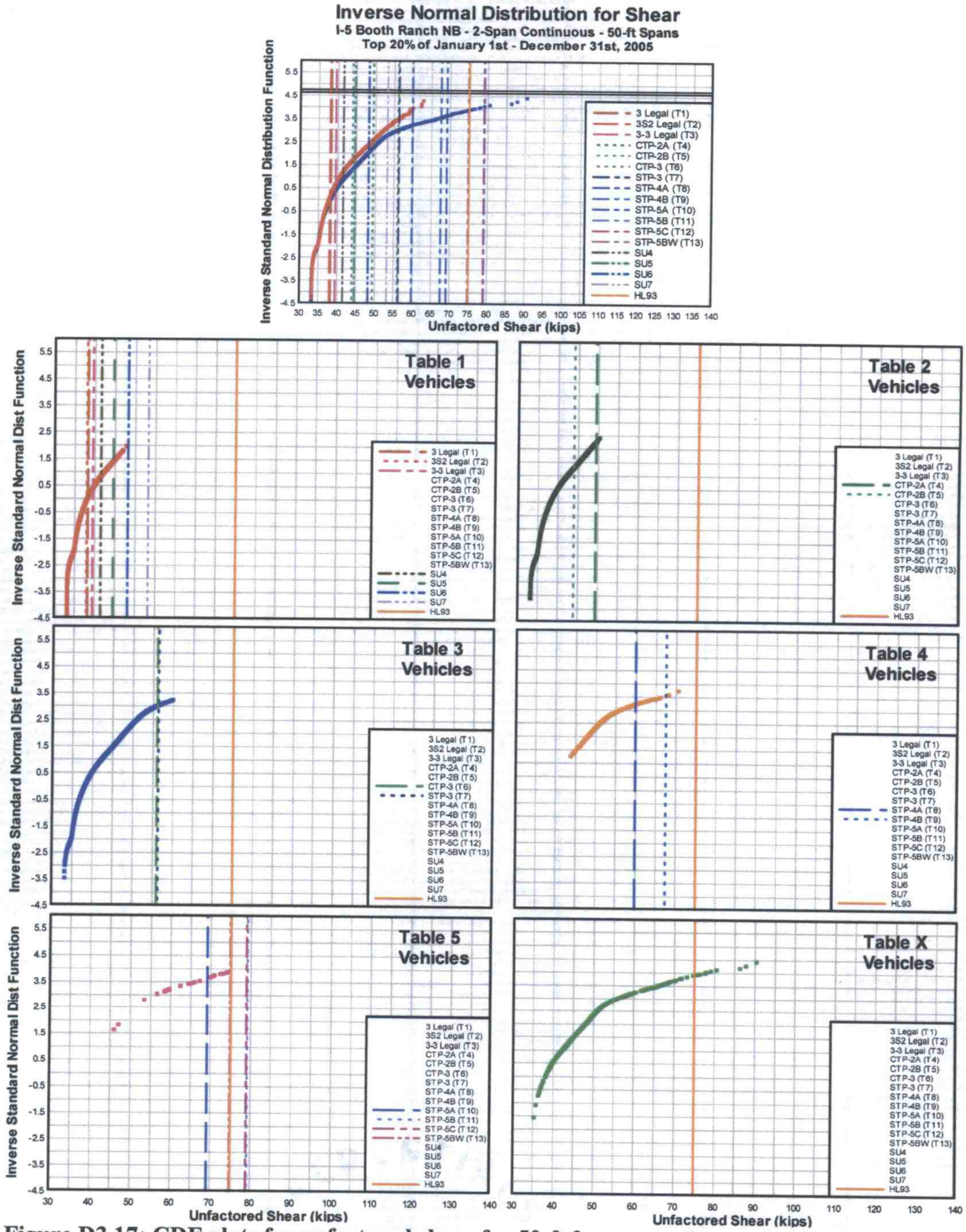


Figure D3.17: CDF plots for unfactored shear for 50-ft 2-span continuous bridge model.

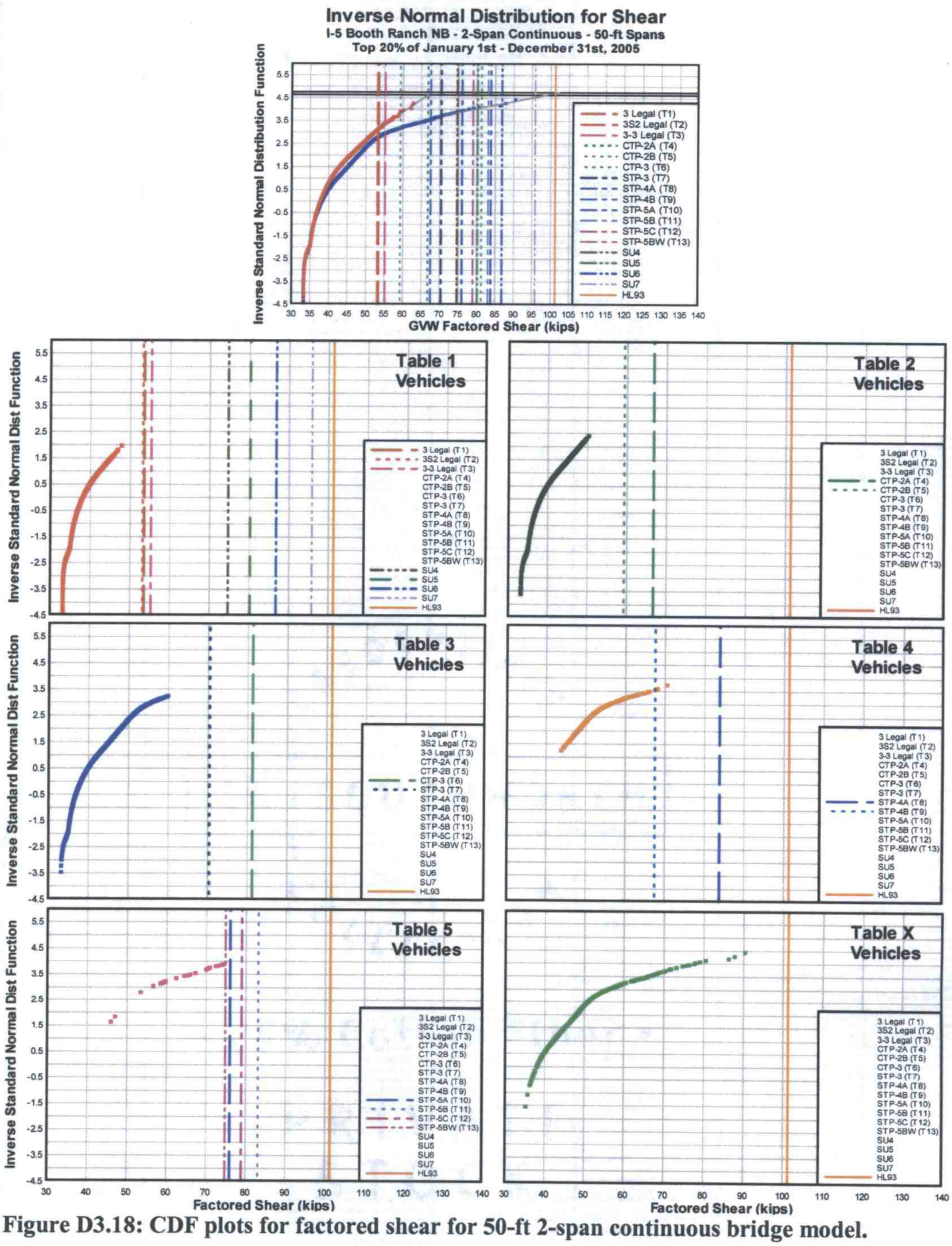


Figure D3.18: CDF plots for factored shear for 50-ft 2-span continuous bridge model.

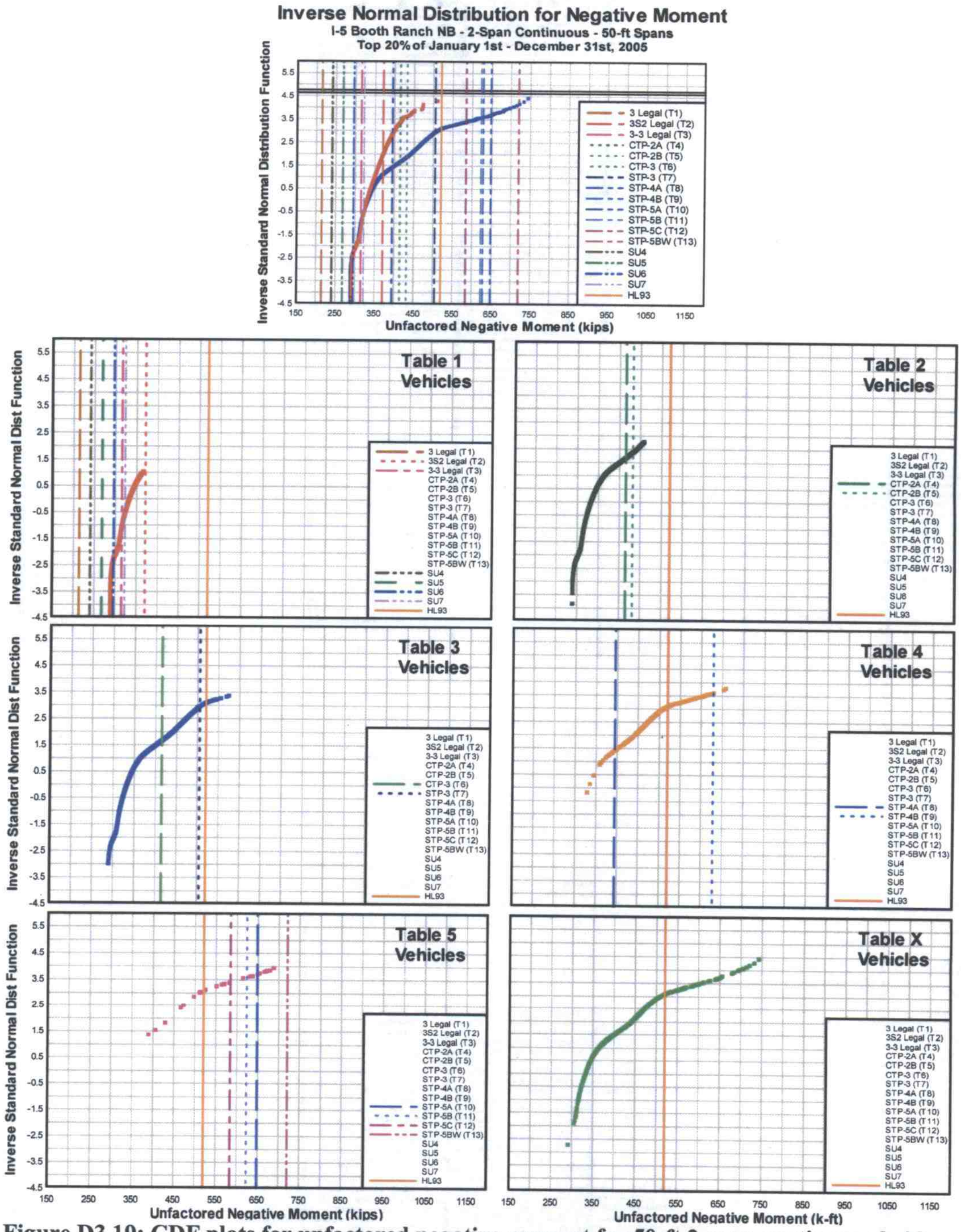


Figure D3.19: CDF plots for unfactored negative moment for 50-ft 2-span continuous bridge model.

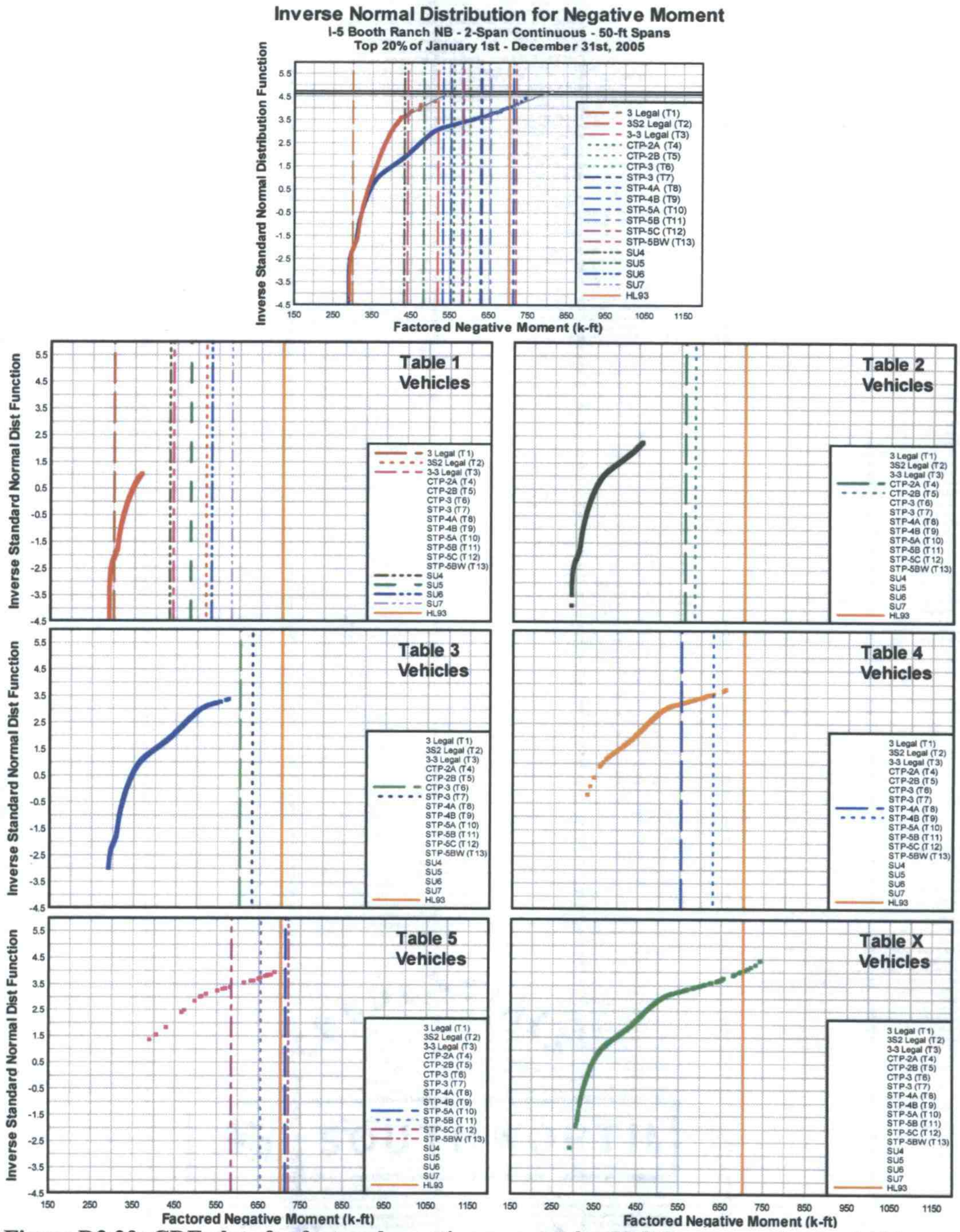


Figure D3.20: CDF plots for factored negative moment for 50-ft 2-span continuous bridge model.

General Conclusions

An investigation of Oregon's weigh-in-motion (WIM) data for bridge rating implementation and evaluation has been performed. The first ever state-wide calibration of live load factors for LRFR bridge evaluation and rating, following the LRFR Manual commentary Article C6.4.4.2.3 for development of site-specific live load factors, has been completed. In addition, a study was conducted to determine an amount of WIM data needed to extrapolate future loading events for both high and low ADTT volume sites. In a separate study, load effects for the Oregon Department of Transportation's (ODOT) suite of 13 bridge rating vehicles were calculated for various span lengths and types. These load effects, both factored and unfactored, were compared to the load effects calculated from vehicles in the WIM data. Based on observations of the data and prior research, the following observations and recommendations are presented:

- Using the statistical data from the four WIM sites with different ADTT volume, at different times of the year, and over different WIM data collection windows, live load factors were computed. The Oregon-specific live load factors were smaller than those in the LRFR Specification. The factors were smaller for the lower volume sites and smaller for the heavier permit trucks.
- The high volume site, I-5 Woodburn NB, showed little seasonal variation, was insensitive to direction of travel, and two-weeks of data were sufficient

to produce consistent factors. For the lower volume sites, some seasonal variation was observed with higher load factors during summer and fall due to agricultural and construction transport.

- By employing the procedures used to develop the LRFR Specification, the resulting live load factors maintain the nationally accepted structural reliability index for evaluation, even though the resulting state-specific live load factors were smaller than the national standard.
- Policy implementation for the Oregon-specific factors included rounding the computed values to the nearest 0.05, set a lower limit of 1.0 for the live load factors, and established provisions for maintenance of the factors into the future.
- For a high ADTT volume site (approximately 3500 ADTT), approximately two weeks of WIM data is needed to adequately extrapolate future upper tail events. For a low ADTT volume site (approximately 500 ADTT), one month of WIM data is needed.
- Additional WIM data should be collected and analyzed. One year of data from two sites was used to project loading events to a five year extrapolation window. As additional data become available, two and five years of collected data should be analyzed and results compared to the rating vehicles, and also to the one-year extrapolation values.

- The factored rating vehicles provided reasonably sufficient demands to envelope the load effects of the WIM data, including that attributed to an adjacent equivalent 3S2 alongside vehicle.
- The contribution of the alongside vehicle in 3S2 equivalents for each of the rating vehicles was presented as a percent of the nominal value to examine the consistency of the reliability between varying span lengths and load effects. Most of the factored rating vehicles produced a fairly uniform level of reliability.
- The Oregon-specific live load factors applied to the rating vehicles adequately enveloped the load effects produced by the WIM data. Some of the rating vehicles that are in current use do not quite produce the same level of demand compared to some WIM vehicles observed on Oregon's state-owned highways. However, the ratios of the rating vehicle load effect to the WIM vehicle load effect that were below 1.0 were reasonably close to 1.0. Considering the level of uncertainty in WIM axle weight measurements, as well as the calibration process, this difference was minor.
- The Type 3 Legal vehicle could be eliminated from the suite of rating vehicles. Additional research should be conducted to further support this recommendation, as stated in subsequent bullets.
- No immediate changes, such as increases in axle weights or reduction of axle spacing lengths are necessary for the suite of ODOT rating vehicles.

- The use of the NRL vehicles to represent Table 1 vehicle classification in Oregon is redundant, and need not be incorporated into to the suite of rating vehicles. Further, the NRLs provided nonuniform levels of reliability compared with the current Table 1 representative vehicles.
- Only one WIM site, I-5 Booth Ranch NB, was considered for comparison of load effects. Additional analyses should be conducted which compare load effects for other routes in Oregon, with varying ADTT, directionality, and freight corridors taken into account.
- Additional span types and lengths should be analyzed when comparing load effects. This may include three-span, four-span, and five-span continuous models with varying span lengths.
- Load effects at the girder level should be calculated and compared for both the WIM data and the rating vehicles using girder distribution factors.
- The factored HL-93 loading (at the operating level) was found to adequately envelope most Table X loading scenarios.

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