

APPENDIX 6

CLOSE COUPLED CALCULATIONS

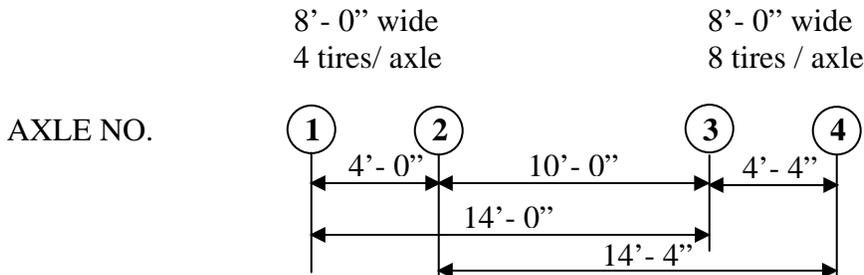
As noted in Chapter III “Close Coupling” exists when two axles of any group of axles are within 18’- 0” of the closest axle of the adjacent group(s) of axles. Notice that balanced loading of all close coupled axles will provide max. gross weight, even when bonused equipment is used. Calculations should be run to determine that axle weights allowed meet close coupled axle group weights for both close coupled axle groups.

The following pages illustrate “Close Coupling” situations including the axle weights for balanced loading and the max. axle group weight on either of the two groups. However, if the applicant provided specific axle group weights other than those shown, the same calculations may be used for the specific application.

“Bonus Factor” is the same percentage given to the axle groups in the Standard Overload Charts. It is applied to each axle when calculating allowable axle group weights on close coupled axle groups.

AXLE WIDTH	NO. OF TIRES/ AXLE	BONUS FACTOR
8’- 0”	4	1.0/ AXLE
8’- 0”	8	1.15/ AXLE
10’- 0”	8	1.25/ AXLE

EXAMPLE:



In the above example axles 1 & 2 have a “Bonus Factor” of 1.0 for each axle. Axles 3 & 4 have a “Bonus Factor” of 1.15 for each axle.

When calculating close coupled axle weights for axle group 1, 2 & 3 the following factors will apply:

Axle 1 = Bonus Factor 1.0
 Axle 2 = Bonus Factor 1.0
 Axle 3 = Bonus Factor 1.15
 Total 3.15

“Bonus Factor” for axle group 1, 2 & 3 equals: 3.15 divided by 3 = 1.05

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When calculating close coupled axle weights for axle group 2, 3 & 4 the following factors will apply:

$$\begin{array}{r} \text{Axle 2} = \text{Bonus Factor } 1.0 \\ \text{Axle 3} = \text{Bonus Factor } 1.15 \\ \text{Axle 4} = \underline{\text{Bonus Factor } 1.15} \\ \text{Total} \quad 3.30 \end{array}$$

“Bonus Factor” for axle group 2, 3 & 4 equals: 3.30 divided by 3 = 1.10

Once the “Bonus Factor” for the axle group has been established, the allowable weight for the axle group can be calculated. Non- bonused weights from the standard overload charts are always used when calculating axle group weights.

Allowable axle group weight for 1, 2 & 3 equals:

$$\begin{array}{r} \text{Straight purple weight for } 14' - 0'' = \text{-----} 56,700 \text{ lbs.} \\ \text{Bonus Factor for } \underline{\text{axles 1, 2 \& 3}} = 1.05 \text{-----} * 1.05 \\ \text{Max. allowable weight} = \text{-----} 59,535 \text{ lbs.} \end{array}$$

Allowable axle group weight for 2, 3 & 4 equals:

$$\begin{array}{r} \text{Straight purple weight for } 14' - 4'' = \text{-----} 57,050 \text{ lbs.} \\ \text{Bonus Factor for } \underline{\text{axles 2, 3 \& 4}} = 1.10 \text{-----} * 1.10 \\ \text{Max. allowable weight} = \text{-----} 62,755 \text{ lbs.} \end{array}$$

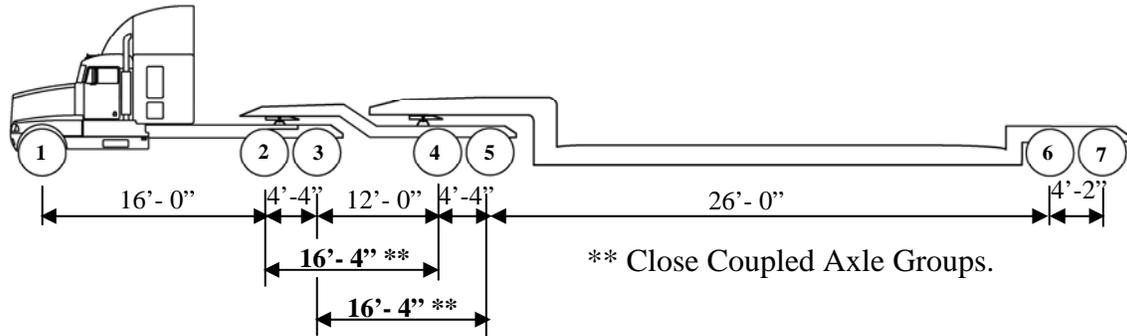
Similar calculations would be run for axle groups incorporating a 10' - 0" wide axle with 8 tires/ axle using the “Bonus Factor” of 1.25. Remember that the straight purple (non- bonus) weight is always used in all close coupled calculations.

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CLOSE COUPLED EXAMPLE No. 1:

Note: 4 tires/ axle & 8' - 0" wide on all axles.
 Bonus factor for all axle groups = 1.0



PURPLE WEIGHT CHART:

Axles 2 & 3 @ 4' - 4" = 46,550 lbs.	Axles 2, 3 & 4 @ 16' - 4" = 59,150 lbs.
Axles 4 & 5 @ 4' - 4" = 46,550 lbs.	Axles 3, 4 & 5 @ 16' - 4" = 59,150 lbs.

FOR BALANCED LOADING ON CLOSE COUPLED GROUPS:

Axles 2, 3 & 4 = 59,150 lbs. divided by 3 = 19,717 lbs./ axle.
 Axles 3, 4 & 5 = 59,150 lbs. divided by 3 = 19,717 lbs./ axle.

NOTE: Balanced loading will prevail for maximum gross weight.

BALANCED LOAD DISTRIBUTION:

Axle 1	Axles 2 & 3	Axles 4&5	Axles 6& 7
12,500 lbs.	(2* 19,717)= 39,434 lbs.	39,434 lbs.	@ 4' - 2"= 46,375 lbs.

FOR MAX. ALLOWABLE WEIGHT ON AXLES 4 & 5:

Question: If max. allowable weight is authorized on axles 4 & 5 how much weight can be allowed on axles 2 & 3 before the axle weights exceed the max. close coupled weight allowed for axle groups 2, 3 & 4 and 3, 4 & 5?

Axle group 2, 3 & 4 controlling would allow:

$$\begin{aligned} \text{Axles 2 \& 3} &= (\text{Total allowed for 2, 3 \& 4}) - (1/2 \text{ max. allowed for 4 \& 5}) \\ &= 59,150 - (1/2 * 46,550) = 35,875 \text{ lbs.} \\ \text{Axles 4 \& 5} &= \text{max. allowed} = 46,550 \text{ lbs.} \end{aligned}$$

Axle group 3, 4 & 5 controlling would allow:

$$\begin{aligned} \text{Axles 2 \& 3} &= \text{Double what is allowed for axle 3} \\ &= 2 * [(\text{Total allowed for 3, 4 \& 5}) - (\text{max. allowed for 4 \& 5})] \\ &= 2 * [59,150 - 46,550] = 25,200 \text{ lbs.} \\ \text{Axles 4 \& 5} &= \text{max. allowed} = 46,550 \text{ lbs.} \end{aligned}$$

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Does either of the above axle weight examples exceed the close coupled allowable of 59,150 lbs for axles 2, 3 & 4 and 59,150 lbs for axles 3, 4 & 5?

Check for controlling group 2, 3 & 4:

Check No. 1
 Axles 2 & 3 = 35,875 lbs.
Axle 4 = 1/2 * 46,550 = 23,275 lbs.
 Axles 2, 3 & 4 = 59,150 lbs.

Check No. 2
 Axle 3 = 1/2 * 35,875 = 17,938 lbs.
Axles 4 & 5 = 46,550 lbs.
 Axles 3, 4 & 5 = 64,488 lbs.

This check shows that axle group 3, 4 & 5 at 64,488 lbs. exceeds the max. allowable for that close coupled group at 59,150 lbs.

Check for controlling group 3, 4 & 5:

Check No. 1
 Axles 2 & 3 = 25,200 lbs.
Axle 4 = 1/2 * 46,550 = 23,275 lbs.
 Axles 2, 3 & 4 = 48,475 lbs.

Check No. 2
 Axle 3 = 1/2 * 25,200 = 12,600 lbs.
Axles 4 & 5 = 46,550 lbs.
 Axles 3, 4 & 5 = 59,150 lbs.

This check shows that both close coupled groups are within the allowable. Therefore, axle group 3, 4 & 5 controls.

Therefore, for max. loading on axles 4 & 5:

Axle 1	Axles 2 & 3	Axles 4 & 5	Axles 6 & 7
12,500 lbs.	25,200 lbs.	46,550 lbs.	46,375 lbs.

Weight Penalty:

Equal loading for axles 2, 3 and 4, 5 ----- = 2 * 39,434 = 78,868 lbs.
 Max. loading axles 4 & 5 ----- = 25,200 + 46,550 = 71,750 lbs.
Weight Penalty = 7,118 lbs.

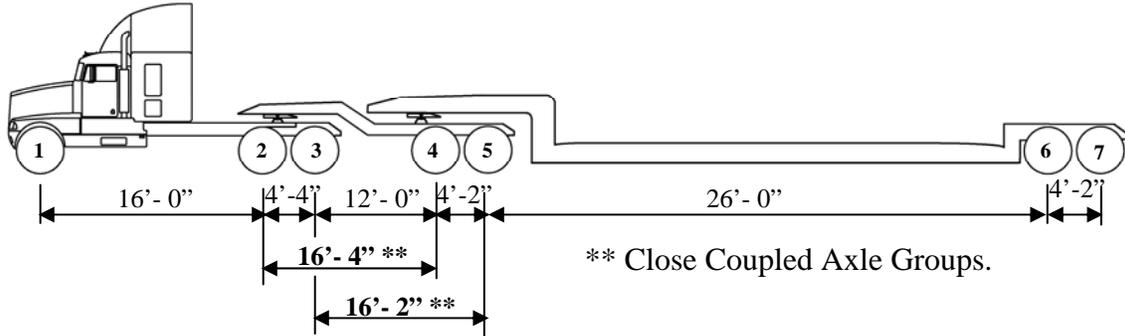
Similar calculations would be run if max. weight on axles 2 & 3 were requested.

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CLOSE COUPLED EXAMPLE No. 2:

Note: 4 tires/ axle & 8' - 0" wide on all axles.
 Bonus factor for all axle groups = 1.0



PURPLE WEIGHT CHART:

Axles 2 & 3 @ 4' - 4" = 46,550 lbs.	Axles 2, 3 & 4 @ 16' - 4" = 59,150 lbs.
Axles 4 & 5 @ 4' - 2" = 46,375 lbs.	Axles 3, 4 & 5 @ 16' - 2" = 58,975 lbs.

FOR BALANCED LOADING ON CLOSE COUPLED GROUPS:

Axles 3, 4 & 5 @ 16' - 2" controls because they have lesser weight.
 Axles 3, 4 & 5 = 58,975 lbs. divided by 3 = 19,658 lbs./ axle.

NOTE: Balanced loading will prevail for maximum gross weight.

BALANCED LOAD DISTRIBUTION:

Axle 1	Axles 2 & 3	Axles 4&5	Axles 6& 7
12,500 lbs.	(2* 19,658)= 39,316 lbs.	39,316 lbs.	@ 4' - 2"= 46,375 lbs.

FOR MAX. ALLOWABLE WEIGHT ON AXLES 4 & 5:

Question: If max. allowable weight is authorized on axles 4 & 5 how much weight can be allowed on axles 2 & 3 before the axle weights exceed the max. close coupled weight allowed for axle groups 2, 3 & 4 and 3, 4 & 5?

Axle group 2, 3 & 4 controlling would allow:

$$\begin{aligned} \text{Axles 2 \& 3} &= (\text{Total allowed for 2, 3 \& 4}) - (1/2 \text{ max. allowed for 4 \& 5}) \\ &= 59,150 - (1/2 * 46,375) = 35,963 \text{ lbs.} \\ \text{Axles 4 \& 5} &= \text{max. allowed} = 46,375 \text{ lbs.} \end{aligned}$$

Axle group 3, 4 & 5 controlling would allow:

$$\begin{aligned} \text{Axles 2 \& 3} &= \text{Double what is allowed for axle 3} \\ &= 2 * [(\text{Total allowed for 3, 4 \& 5}) - (\text{max. allowed for 4 \& 5})] \\ &= 2 * [58,975 - 46,375] = 25,200 \text{ lbs.} \\ \text{Axles 4 \& 5} &= \text{max. allowed} = 46,375 \text{ lbs.} \end{aligned}$$

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Does either of the above axle weight examples exceed the close coupled allowable of 59,150 lbs for axles 2, 3 & 4 and 58,975 lbs for axles 3, 4 & 5?

Check for controlling group 2, 3 & 4:

Check No. 1

Axles 2 & 3 = 35,963 lbs.

Axle 4 = 1/2 * 46,375 = 23,187 lbs.

Axles 2, 3 & 4 = 59,150 lbs.

Check No. 2

Axle 3 = 1/2 * 35,963 = 17,981 lbs.

Axles 4 & 5 = 46,375 lbs.

Axles 3, 4 & 5 = 64,356 lbs.

This check shows that axle group 3, 4 & 5 at 64,356 lbs. exceeds the max. allowable for that close coupled group at 58,975 lbs.

Check for controlling group 3, 4 & 5:

Check No. 1

Axles 2 & 3 = 25,200 lbs.

Axle 4 = 1/2 * 46,375 = 23,187 lbs.

Axles 2, 3 & 4 = 48,387 lbs.

Check No. 2

Axle 3 = 1/2 * 25,200 = 12,600 lbs.

Axles 4 & 5 = 46,375 lbs.

Axles 3, 4 & 5 = 58,975 lbs.

This check shows that both close coupled axle groups are within the allowable. Therefore, axle group 3, 4 & 5 controls.

Therefore, for max. loading on axles 4 & 5:

Axle 1	Axles 2 & 3	Axles 4 & 5	Axles 6 & 7
12,500 lbs.	25,200 lbs.	46,375 lbs.	46,375 lbs.

Weight Penalty:

Equal loading for axles 2, 3 and 4, 5 ----- = 2 * 39,316 = 78,632 lbs.

Max. loading axles 4 & 5 ----- = 25,200 + 46,375 = 71,575 lbs.

Weight Penalty = 7,057 lbs.

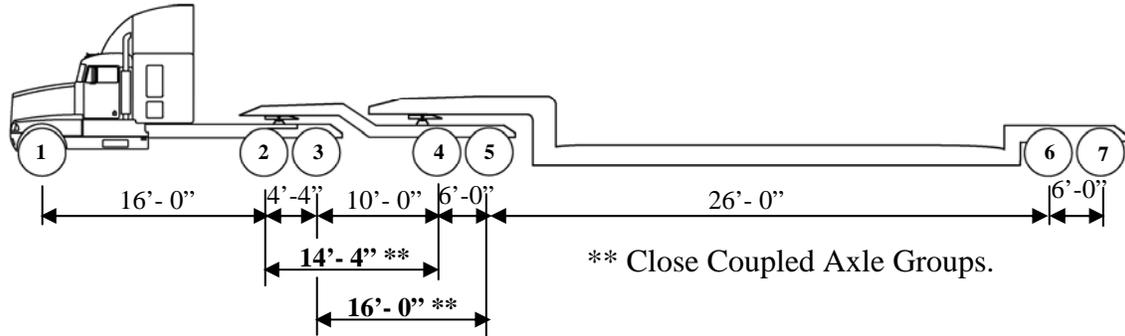
Similar calculations would be run if max. weight on axles 2 & 3 were requested.

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CLOSE COUPLED EXAMPLE No. 3:

Note: 4 tires/ axle & 8' - 0" wide on axles 2 & 3.
 8 tires/ axle & 8' - 0" wide on axles 4, 5, 6 & 7. Bonus factor 1.15.
 Bonus factor for axle group 2, 3 & 4 = $(1.0 + 1.0 + 1.15) / 3 = 1.05$.
 Bonus factor for axle group 3, 4 & 5 = $(1.0 + 1.15 + 1.15) / 3 = 1.10$.



PURPLE WEIGHT CHART:

Axles 2 & 3 @ 4' - 4" = 46,550 lbs.
 Axles 4 & 5 @ 6' - 0" = 48,300 * 1.15 = 55,545 lbs.
 Axles 2, 3 & 4 @ 14' - 4" = 57,050 * 1.05 = 59,902 lbs.
 Axles 3, 4 & 5 @ 16' - 0" = 58,800 * 1.10 = 64,680 lbs.

FOR BALANCED LOADING ON CLOSE COUPLED GROUPS:

Axles 2, 3 & 4 @ 14' - 4" controls because they have lesser weight.
 Axles 2, 3 & 4 = 59,902 lbs. divided by 3 = 19,967 lbs./ axle.

NOTE: Balanced loading will prevail for maximum gross weight.

BALANCED LOAD DISTRIBUTION:

Axle 1	Axles 2 & 3	Axles 4&5	Axles 6 & 7
12,500 lbs.	$(2 * 19,967) = 39,934$ lbs.	39,934 lbs.	@ 6' - 0" = 55,545 lbs.

FOR MAX. ALLOWABLE WEIGHT ON AXLES 4 & 5:

Question: If max. allowable weight is authorized on axles 4 & 5 how much weight can be allowed on axles 2 & 3 before the axle weights exceed the max. close coupled weight allowed for axle groups 2, 3 & 4 and 3, 4 & 5?

Axle group 2, 3 & 4 controlling would allow:

$$\begin{aligned} \text{Axles 2 \& 3} &= (\text{Total allowed for 2, 3 \& 4}) - (1/2 \text{ max. allowed for 4 \& 5}) \\ &= 59,902 - (1/2 * 55,545) = 32,130 \text{ lbs.} \\ \text{Axles 4 \& 5} &= \text{max. allowed} = 55,545 \text{ lbs.} \end{aligned}$$

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Axle group 3, 4 & 5 controlling would allow:

$$\begin{aligned} \text{Axles 2 \& 3} &= \text{Double what is allowed for axle 3} \\ &= 2 * [(\text{Total allowed for 3, 4 \& 5}) - (\text{max. allowed for 4 \& 5})] \\ &= 2 * [64,680 - 55,545] = 18,270 \text{ lbs.} \\ \text{Axles 4 \& 5} &= \text{max. allowed} = 55,545 \text{ lbs.} \end{aligned}$$

Does either of the above axle weight examples exceed the close coupled allowable of 59,902 lbs for axles 2, 3 & 4 and 64,680 lbs for axles 3, 4 & 5?

Check for controlling group 2, 3 & 4:

Check No. 1

$$\begin{aligned} \text{Axles 2 \& 3} &= 32,130 \text{ lbs.} \\ \text{Axle 4} &= 1/2 * 55,545 = 27,772 \text{ lbs.} \\ \text{Axles 2, 3 \& 4} &= 59,902 \text{ lbs.} \end{aligned}$$

Check No. 2

$$\begin{aligned} \text{Axle 3} &= 1/2 * 32,130 = 16,065 \text{ lbs.} \\ \text{Axles 4 \& 5} &= 55,545 \text{ lbs.} \\ \text{Axles 3, 4 \& 5} &= 71,610 \text{ lbs.} \end{aligned}$$

This check shows that axle group 3, 4 & 5 at 71,610 lbs. exceeds the max. allowable for that close coupled group at 59,902 lbs.

Check for controlling group 3, 4 & 5:

Check No. 1

$$\begin{aligned} \text{Axles 2 \& 3} &= 18,270 \text{ lbs.} \\ \text{Axle 4} &= 1/2 * 55,545 = 27,772 \text{ lbs.} \\ \text{Axles 2, 3 \& 4} &= 46,042 \text{ lbs.} \end{aligned}$$

Check No. 2

$$\begin{aligned} \text{Axle 3} &= 1/2 * 18,270 = 9,135 \text{ lbs.} \\ \text{Axles 4 \& 5} &= 55,545 \text{ lbs.} \\ \text{Axles 3, 4 \& 5} &= 64,680 \text{ lbs.} \end{aligned}$$

This check shows that both close coupled axle groups are within the allowable. Therefore, axle group 3, 4 & 5 controls.

Therefore, for max. loading on axles 4 & 5:

Axle 1	Axles 2 & 3	Axles 4 & 5	Axles 6 & 7
12,500 lbs.	18,270 lbs.	55,545 lbs.	55,545 lbs.

Weight Penalty:

Equal loading for axles 2, 3 and 4, 5 ----- = $2 * 39,934 = 79,868$ lbs.

Max. loading axles 4 & 5 ----- = $18,270 + 55,545 = 73,815$ lbs.

Weight Penalty = 6,053 lbs.

Similar calculations would be run if max. weight on axles 2 & 3 were requested.

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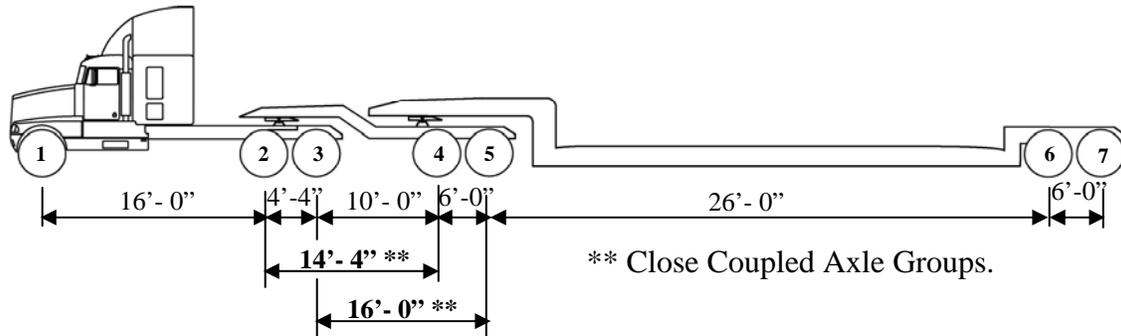
CLOSE COUPLED EXAMPLE No. 4:

Note: 4 tires/ axle & 8' - 0" wide on axles 2 & 3.

8 tires/ axle & 10' - 0" wide on axles 4, 5, 6 & 7. Bonus factor 1.25.

Bonus factor for axle group 2, 3 & 4 = $(1.0 + 1.0 + 1.25) / 3 = 1.08$.

Bonus factor for axle group 3, 4 & 5 = $(1.0 + 1.25 + 1.25) / 3 = 1.17$.



PURPLE WEIGHT CHART:

Axles 2 & 3 @ 4' - 4" = 46,550 lbs.

Axles 4 & 5 @ 6' - 0" = 48,300 * 1.25 = 60,375 lbs. *Use max. allowable for tandem of 60,000 lbs.*

Axles 2, 3 & 4 @ 14' - 4" = 57,050 * 1.08 = 61,614 lbs.

Axles 3, 4 & 5 @ 16' - 0" = 58,800 * 1.17 = 68,796 lbs.

FOR BALANCED LOADING ON CLOSE COUPLED GROUPS:

Axles 2, 3 & 4 @ 14' - 4" controls because they have lesser weight.

Axles 2, 3 & 4 = 61,614 lbs. divided by 3 = 20,538 lbs./ axle.

NOTE: Balanced loading will prevail for maximum gross weight.

BALANCED LOAD DISTRIBUTION:

Axle 1	Axles 2 & 3	Axles 4&5	Axles 6 & 7
12,500 lbs.	(2* 20,538)= 41,076 lbs.	41,076 lbs.	@ 6' - 0"= 60,000 lbs.

FOR MAX. ALLOWABLE WEIGHT ON AXLES 4 & 5:

Question: If max. allowable weight is authorized on axles 4 & 5 how much weight can be allowed on axles 2 & 3 before the axle weights exceed the max. close coupled weight allowed for axle groups 2, 3 & 4 and 3, 4 & 5?

Axle group 2, 3 & 4 controlling would allow:

$$\begin{aligned} \text{Axles 2 \& 3} &= (\text{Total allowed for 2, 3 \& 4}) - (1/2 \text{ max. allowed for 4 \& 5}) \\ &= 61,614 - (1/2 * 60,000) = 31,614 \text{ lbs.} \end{aligned}$$

$$\text{Axles 4 \& 5} = \text{max. allowed} = 60,000 \text{ lbs.}$$

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Axle group 3, 4 & 5 controlling would allow:

$$\begin{aligned} \text{Axles 2 \& 3} &= \text{Double what is allowed for axle 3} \\ &= 2 * [(\text{Total allowed for 3, 4 \& 5}) - (\text{max. allowed for 4 \& 5})] \\ &= 2 * [68,796 - 60,000] = 17,592 \text{ lbs.} \\ \text{Axles 4 \& 5} &= \text{max. allowed} = 60,000 \text{ lbs.} \end{aligned}$$

Does either of the above axle weight examples exceed the close coupled allowable of 61,614 lbs for axles 2, 3 & 4 and 68,796 lbs for axles 3, 4 & 5?

Check for controlling group 2, 3 & 4:

Check No. 1

$$\begin{aligned} \text{Axles 2 \& 3} &= 31,614 \text{ lbs.} \\ \text{Axle 4} &= 1/2 * 60,000 = 30,000 \text{ lbs.} \\ \text{Axles 2, 3 \& 4} &= 61,614 \text{ lbs.} \end{aligned}$$

Check No. 2

$$\begin{aligned} \text{Axle 3} &= 1/2 * 31,614 = 15,807 \text{ lbs.} \\ \text{Axles 4 \& 5} &= 60,000 \text{ lbs.} \\ \text{Axles 3, 4 \& 5} &= 75,807 \text{ lbs.} \end{aligned}$$

This check shows that axle group 3, 4 & 5 at 75,807 lbs. exceeds the max. allowable for that close coupled group at 58,796 lbs.

Check for controlling group 3, 4 & 5:

Check No. 1

$$\begin{aligned} \text{Axles 2 \& 3} &= 17,592 \text{ lbs.} \\ \text{Axle 4} &= 1/2 * 60,000 = 30,000 \text{ lbs.} \\ \text{Axles 2, 3 \& 4} &= 47,592 \text{ lbs.} \end{aligned}$$

Check No. 2

$$\begin{aligned} \text{Axle 3} &= 1/2 * 17,592 = 8,796 \text{ lbs.} \\ \text{Axles 4 \& 5} &= 60,000 \text{ lbs.} \\ \text{Axles 3, 4 \& 5} &= 68,796 \text{ lbs.} \end{aligned}$$

This check shows that both close coupled axle groups are within the allowable. Therefore, axle group 3, 4 & 5 controls.

Therefore, for max. loading on axles 4 & 5:

Axle 1	Axles 2 & 3	Axles 4 & 5	Axles 6 & 7
12,500 lbs.	17,592 lbs.	60,000 lbs.	60,000 lbs.

Weight Penalty:

$$\begin{aligned} \text{Equal loading for axles 2, 3 and 4, 5} &= 2 * 41,076 = 82,152 \text{ lbs.} \\ \text{Max. loading axles 4 \& 5} &= 17,592 + 60,000 = 77,592 \text{ lbs.} \\ \text{Weight Penalty} &= 4,560 \text{ lbs.} \end{aligned}$$

Similar calculations would be run if max. weight on axles 2 & 3 were requested.