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Payload Weight Distribution of the PJ 96-inch Deckover Trailer

by Steven Callaway

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1. Introduction

The Satellite Terminal Trailer System is a trailer mounting system that allows the terminal to be mounted and transported by a flatbed trailer instead of being attached to a larger vehicle. The customer required an increase in range, operational time, and mobility over the original configuration. To accomplish this, the satellite terminal is mounted directly to a flat deck trailer with an auxiliary fuel tank and tool storage.

2. Trailer Tongue Weight

For a trailer to operate in a safe manner, it must have the correct tongue weight. Tongue weight is best described by the weight of the trailer and the payload supported by the tow vehicle.¹ If the tongue weight is too high, the tow vehicle can become overloaded, degrading handling characteristics. If the tongue weight is too low, the trailer will have a tendency to sway during operation, creating a potentially dangerous situation. For safe operation, tongue weight is suggested to be 10%–15% of the gross trailer weight.²

The PJ Trailers D8 Deckover Dump trailer (Fig. 1) was chosen for its large flat deck surface. The trailer measures 96 inches across and is available with a 14-ft length. The customer required that the length be limited to 14 ft to maintain trailer maneuverability. With a 4100-lb base weight and a 14,000-lb gross vehicle weight rating, the trailer offers a 9900-lb payload weight capability.



Fig. 1 PJ Trailers D8 Deckover Dump trailer³

3. Tongue Weight Curve

To ensure a proper tongue weight, once the trailer was fully loaded the tongue weight curve was created. A vehicle scale was placed under the coupler of the trailer so that the tongue weight, F_T , could be measured. The satellite terminal was placed at various positions on the trailer, and the tongue weight recorded. The distance from the front of the trailer to the center of gravity of the satellite terminal, x_{cg} , was used to characterize the position. Figures 2 and 3 illustrate the tongue weight measurement and satellite terminal location characterization.

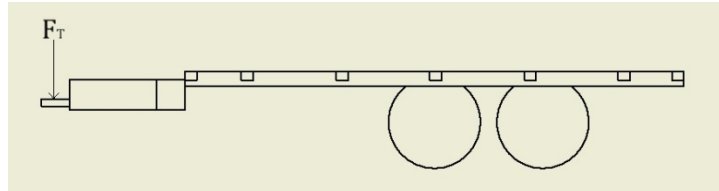


Fig. 2 Trailer side profile; tongue weight F_T indicated

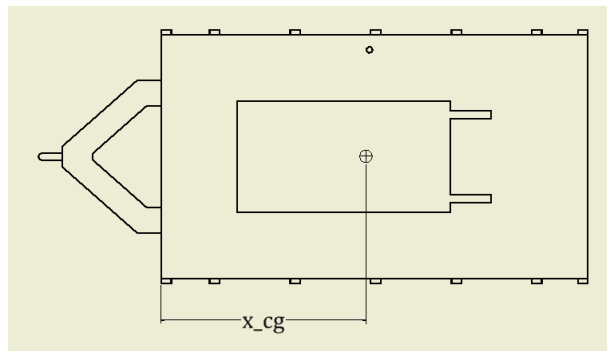


Fig. 3 Trailer top view; distance from front of trailer to center of gravity of satellite terminal, x_{cg} , indicated

The satellite terminal was placed at two positions, and the tongue weight recorded (Table 1). Linearly interpolating between these two values yields the tongue weight curve; this will later be used to determine component location on the trailer.

Table 1 Recorded satellite terminal location and tongue weight

x_{cg} (inches)	F_T (lb)	Load (%)
72.25	436	16.02
76.625	381	14.00
77.75 ^a	366 ^a	13.46

^a Third row values confirmed using tongue weight curve.

$$F_T = m \cdot x_{cg} + b \quad (1)$$

Using row 1 values from Table 1:

$$436 = m \cdot 72.25 + b$$

$$b = 436 - 72.25m \quad (2)$$

Substituting Eq. 2 into Eq. 1:

$$F_T = m \cdot (x_{cg} - 72.25) + 436$$

Using row 2 values from Table 1:

$$381 = m \cdot (76.625 - 72.25) + 436$$

$$m = -12.571$$

Substituting the value m into Eq. 2 yields

$$b = 1344.25$$

This gives the tongue weight curve:

$$F_T = -12.571x_{cg} + 1344.25$$

4. Equipment Placement

Once the tongue weight curve was created, the appropriate equipment placement could be determined (Fig. 4). The customer required that a 70-gal diesel fuel tank be used as well as a storage container/toolbox to support the satellite terminal. It was required that the diesel fuel tank be mounted near the front of the trailer for convenient refueling access. Both an empty and full diesel fuel tank were taken into account to ensure the trailer would be safe to tow at any fuel level.

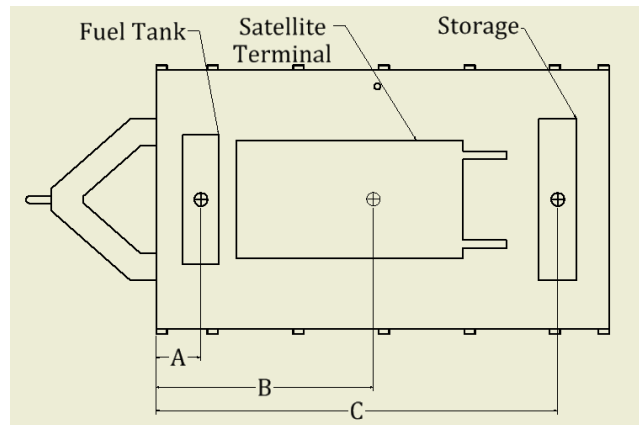


Fig. 4 Trailer layout with approximate equipment location

Table 2 shows that the total tongue weight with a full tank of fuel is 15.02% of the total payload. This falls within the requirement for maximum tongue weight.

Table 2 Tongue weight calculation with full fuel tank

Equipment	Total weight (lb)	A (inches)	B (inches)	C (inches)	F_T (lb)
Fuel tank (full)	554	16.6	...	...	231.11
Satellite terminal	2720	...	80.25	...	335.33
Storage	200	...	...	155	-44.36
				Total:	522.07
				% Load:	15.02%

Table 3 shows that the total tongue weight with an empty tank of fuel is 10.68% of the total payload. This falls within the requirement for minimum tongue weight.

Table 3 Tongue weight calculation with empty fuel tank

Equipment	Total weight (lb)	A (inches)	B (inches)	C (inches)	F_T (lb)
Fuel tank (empty)	68	16.6	...	...	28.36
Satellite terminal	2720	...	80.25	...	335.33
Storage	200	...	...	155	-44.36
				Total:	319.33
				% Load:	10.68%

5. Conclusion

Every trailer system that is pulled with a ball-mounted hitch requires a tongue weight between 10% and 15% of the gross trailer weight. Too high of a tongue weight overloads the tow vehicle, and too low of a tongue weight promotes trailer swaying. The Satellite Terminal Trailer System is no different. As the components of the system are placed, they need to maintain 10%–15% tongue weight. The tongue loading characteristics of the PJ trailer were experimentally determined using a car scale while varying the location of the satellite terminal. Once the tongue loading curve was determined, mounting locations for all of the system components were established, ensuring safe and effective trailer operation.

6. References

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