

**NATIONAL TRANSPORTATION SAFETY BOARD**  
Office of Research and Engineering  
Washington, D.C. 20594

January 10, 2020

## **Video Study**

**NTSB Case Number:  
HWY19FH008**

### **A. ACCIDENT**

Location: Delray Beach, Florida  
Date: March 1, 2019  
Time: 6:17 a.m. EST  
Vehicle No. 1: 2018 Tesla Model 3  
Vehicle No. 2: 2019 International truck-tractor in combination with a semitrailer

### **B. AUTHOR**

Dan T. Horak  
NTSB

### **C. ACCIDENT SUMMARY**

For a summary of the accident, refer to the *Crash Summary Report* in the docket for this investigation.

### **D. DETAILS OF INVESTIGATION**

The goal of this study was estimating the speed of the combination vehicle as it pulled from a private driveway and traveled east across the southbound lanes of US 441, blocking the path of the Tesla. The analysis was based on a video recorded by a forward-facing camera on the Tesla.

Figure 1 shows a segment from a frame from the Tesla video recorded about 1.5 seconds before the Tesla collided with the trailer. The video had resolution of 1280x960, frame rate of 36 fps and duration of 6.4 seconds. It was not known whether this was the original video recorded by the Tesla camera or a version with a different frame rate. Accurate frame rate was required for accurate speed estimation. Therefore, the 36 fps frame rate was verified based on the speed of the Tesla and the distance it traveled just before the collision.

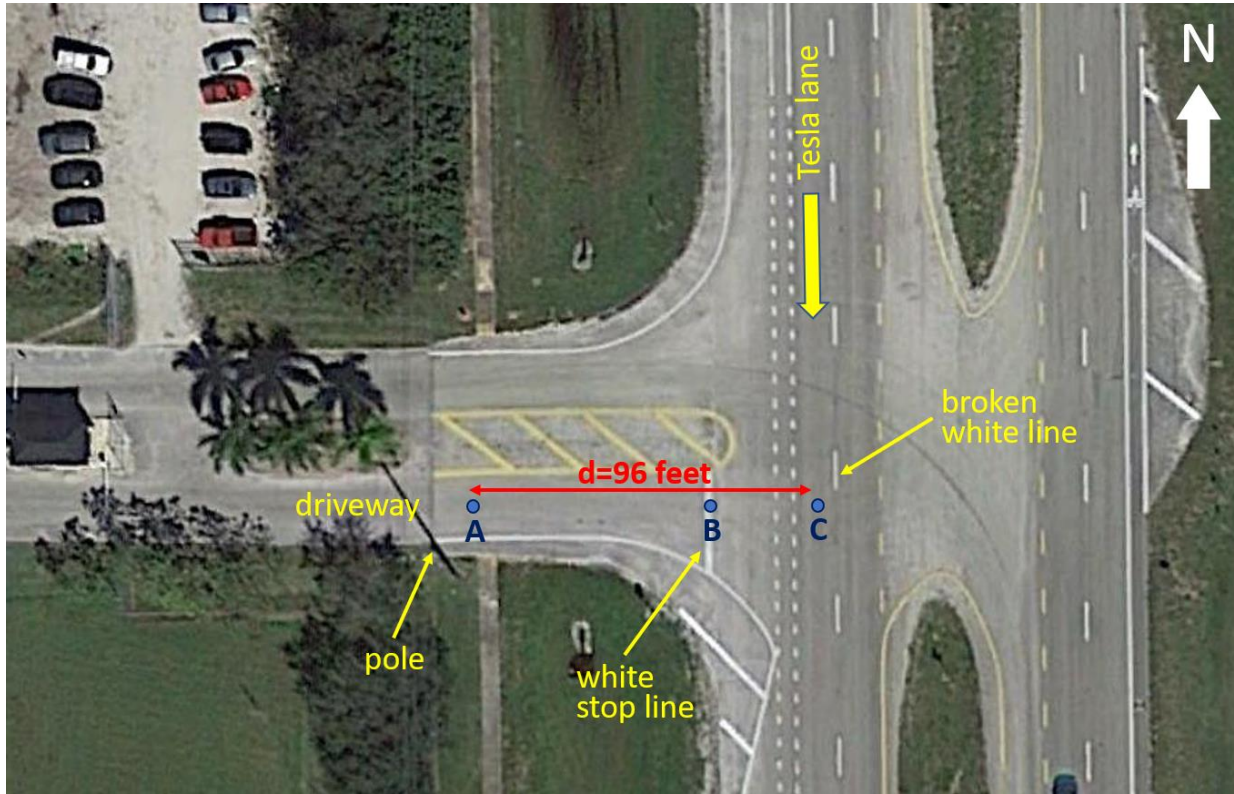


**Figure 1. Segment from a Video Frame Recorded 1.5 seconds before Collision**

The Tesla data log file indicated that just before the collision, the speed was 68.4 mph. The two through lanes on southbound US 441 are divided by broken white lines consisting of 10-foot-long white segments and 30-foot-long gaps, as seen in Figure 2. Google Earth measurements indicated that these lengths are accurate at the site of the accident. The video showed that the Tesla traveled across ten white segments in 4.016 seconds. Therefore, the video-based speed estimate of the Tesla just before the impact location is  $400/4.016=99.6 \text{ ft/s}=67.9 \text{ mph}$ . The better than 1% agreement between the two speeds, 68.4 mph and 67.9 mph, showed that the frame rate of the analyzed video was correct and could be used in the analysis that follows.

Marked points A, B and C in Figure 2 are at locations that were used for speed estimation. Point A is the location of the rear of the trailer when the Tesla video showed the left rear corner of the trailer aligned with the power line pole marked in Figure 2. Point B is the location of the front bumper of the truck-tractor when the rear of the trailer was at point A. Point C is at the center of the lane where the Tesla was traveling. The distance from A to C is marked in the figure and is  $d=96$  feet.

This accident developed over a short time. About two seconds after the front bumper of the truck-tractor crossed the white stop line on the driveway (see Figure 2), the truck-tractor was already blocking the Tesla's lane. About one second later, the trailer was blocking the lane, as seen in Figure 1. Since the collision happened about 1.5 seconds after that, there were less than 4.5 seconds available for estimating the speed of the combination vehicle.



**Figure 2. Aerial View of the Accident Site**

Three speed estimates were derived. In each case, the traveled distance was estimated based on video frames and Google Earth measurements and the time it took to travel that distance was estimated based on the number of elapsed video frames. The three speed estimates are described next.

1. Speed estimate based on the distance traveled from the time the rear of the trailer was at point A to when the front of the trailer was at point C. Let the length of the trailer be  $L=53$  feet. Therefore, the traveled distance was  $d-L=96-53=43$  feet. It took 2.72 seconds to travel this distance. Therefore, the estimated speed of the combination vehicle was  $43/2.72 = 15.8 \text{ ft/s} = 10.8 \text{ mph}$ .
2. Speed estimate based on the distance traveled from the time when the rear of the trailer was at point A to when the center of the trailer was at point C. The traveled distance was  $d-L/2=69.5$  feet. It took 4.35 seconds to travel this distance. The estimated speed of the combination vehicle was  $69.5/4.35 = 16.0 \text{ ft/s} = 10.9 \text{ mph}$ .
3. Speed estimate based on the distance traveled from the time the front end of the trailer was at point C to when the center of the trailer was at point C. The traveled distance was  $L/2=26.5$  feet and the elapsed time was 1.63 seconds. The estimated speed of the combination vehicle was  $26.5/1.63 = 16.3 \text{ ft/s} = 11.1 \text{ mph}$ .

Speed estimate No. 1, 10.8 mph, represents the average speed with which the combination vehicle exited the driveway and moved toward the US 441 lanes.

Speed estimate No. 2, 10.9 mph, is over the longest traveled distance and the longest time period. It is the average speed during the 4.35 seconds when accurate speed estimation was possible.

Speed estimate No. 3, 11.1 mph, is the average speed with which the trailer was entering the lane in which the Tesla was traveling. The speed is estimated over a relatively short distance just before impact, but the locations of the trailer can be estimated accurately, resulting in an accurate speed estimate.

The three speed estimates indicate that the speed of the combination vehicle was constant during the 4.35 seconds that were analyzed. The small differences between the three estimated speeds are well within the accuracy tolerance of the estimation process. Therefore, the speed of the combination vehicle can be specified as  $11 \pm 0.5$  mph where the  $\pm 0.5$  mph accounts for all possible sources of estimation inaccuracy.

## **E. CONCLUSIONS**

Video recorded by a forward-facing camera installed on a Tesla car was used for estimating the speed of a combination vehicle that moved across the lanes of US 441 and blocked the lane in which the Tesla was traveling. The combination vehicle was moving at the estimated speed of  $11 \pm 0.5$  mph across the lanes.