

NATIONAL TRANSPORTATION SAFETY BOARD

Office of Research and Engineering
Washington, D.C. 20594

May 11, 2022

Video Study

**NTSB Case Number:
HWY21FH011**

A. ACCIDENT

Location: Coral Gables, Florida
Date: September 13, 2021
Time: 8:55 PM Eastern Daylight Time
Vehicle No.1: 2021 Tesla Model 3 (Tesla)
Vehicle No.2: Witness Vehicle (Witness)

B. AUTHOR

Shane K. Lack
NTSB

C. ACCIDENT SUMMARY

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

D. DETAILS OF INVESTIGATION

The goals of this study were to estimate the speed of the Tesla, and to document the traffic light changes visible in the video in the seconds prior to the crash. Analysis is based on a video recorded by a camera installed on a witness vehicle and electronic speed data downloaded from the Tesla. One video was available from an outside-view, forward-facing camera on the witness vehicle which was traveling behind the Tesla when it crashed. The video had 1920X352 resolution and a frame rate of 60 fps. Examination of the video found that it contained duplicate images of each frame which were accounted for in the analysis.

Northbound Alhambra Circle in Coral Gables Florida near the accident location is two lanes, one northbound and one southbound; the posted speed limit is 30 mph. The witness vehicle was traveling north on Alhambra Circle. As seen in the video, the

northbound Tesla passes the witness vehicle several seconds prior to the accident. After passing the witness vehicle, the Tesla then reenters the northbound lane before crossing the intersection of Alhambra Circle with Coral Way and crashing into trees in the center median. The intersection of Alhambra Circle and Coral Way is controlled by a traffic signal and the signal was visible in the video. As indicated by the video, the accident occurred during the hours of darkness and the street was lighted.

Conventions

The Tesla struck two trees located in the median of Alhambra Circle in quick succession before coming to rest. After striking the second tree, the Tesla rotated clockwise around the tree before coming to rest close to the base of the tree. For the purposes of this report the Time-To-Collision (TTC) and Distance-to-Collision (DTC) are referenced to the second (last) tree the Tesla struck before coming to final rest. When the word “collision” is used in the report it refers to the collision with the second tree.

Electronic Speed Data from the Tesla

Speed data downloaded from the Electronic Data Recorder (EDR) on the Tesla and used in the study are shown in Figure 1. TTC zero is the collision between the Tesla and the second tree.

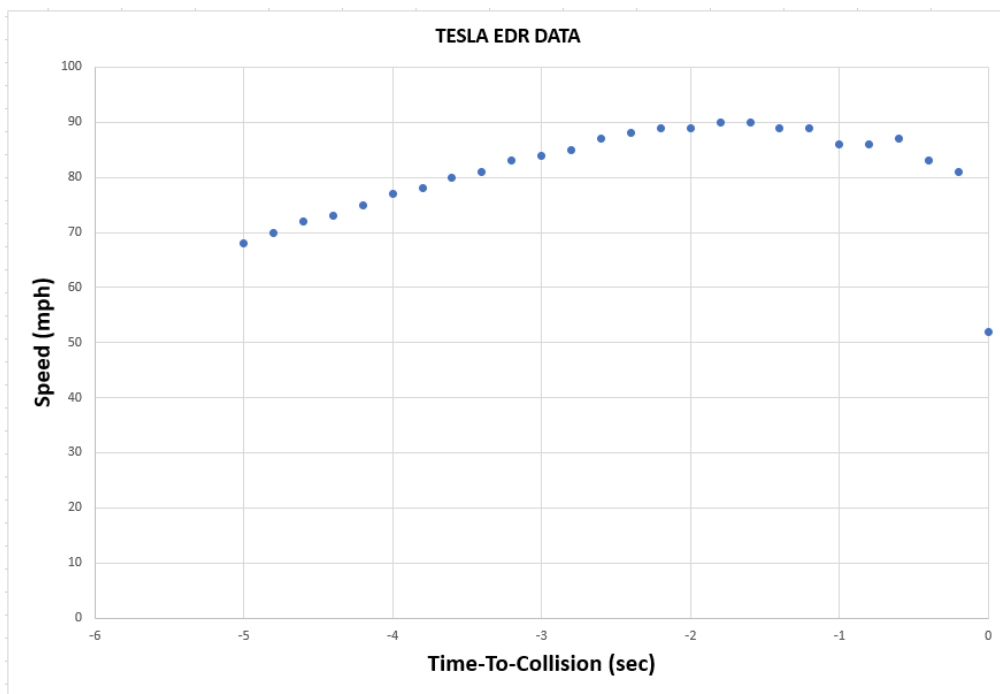


Figure 1. Electronic speed data downloaded from the Tesla. Zero is the approximate time of collision with the second tree. Negative time indicates time prior to the collision.

Analysis of the Video and Comparison with Electronic Speed Data from the Tesla

The location of the Tesla along the roadway in the video was estimated by identifying when the right edge of the headlight beam pattern from the Tesla's headlights (light cone) passed by trees located along the east side of Alhambra Circle in the video. The positions of the trees were then located using survey information (roadway plans, survey measurements taken by the NTSB, and Google Earth) and this information was used to estimate the position of the Tesla as it passed by the trees in the video. To account for the fact that the Tesla headlight beam passed by the trees slightly before the Tesla, an additional ten feet was added to the DTC estimates. One additional point was identified from the vertical movement of the Tesla in the video as it passed over a "bump" in the intersection of Alhambra Circle with Coral Way. The location of this "bump" was documented in survey data gathered by the NTSB.

Estimates of the DTC versus TTC for the Tesla based on the video analysis and EDR data (estimated by integrating the speed data in Figure 1) are plotted in Figure 2.

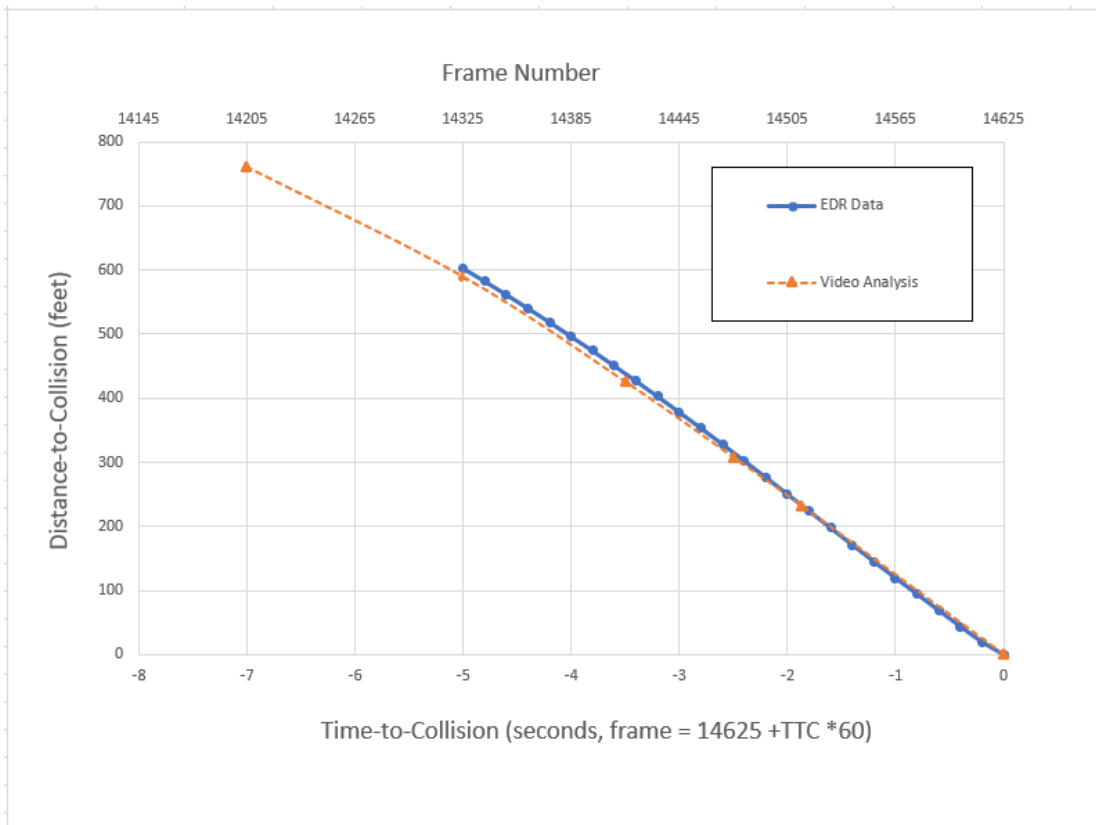


Figure 2. Estimates of DTC versus TTC for the Tesla. Time zero is the collision between the Tesla and the second (final) tree. Negative time indicates time prior to the collision.

The accelerator pedal status, Steering Wheel Angle (SWA) and service brake status data obtained from the Tesla's EDR are plotted along with the results of the video analysis in Figure 3. The figure also contains information on the status of the traffic light based on the video analysis which is described later in the report.

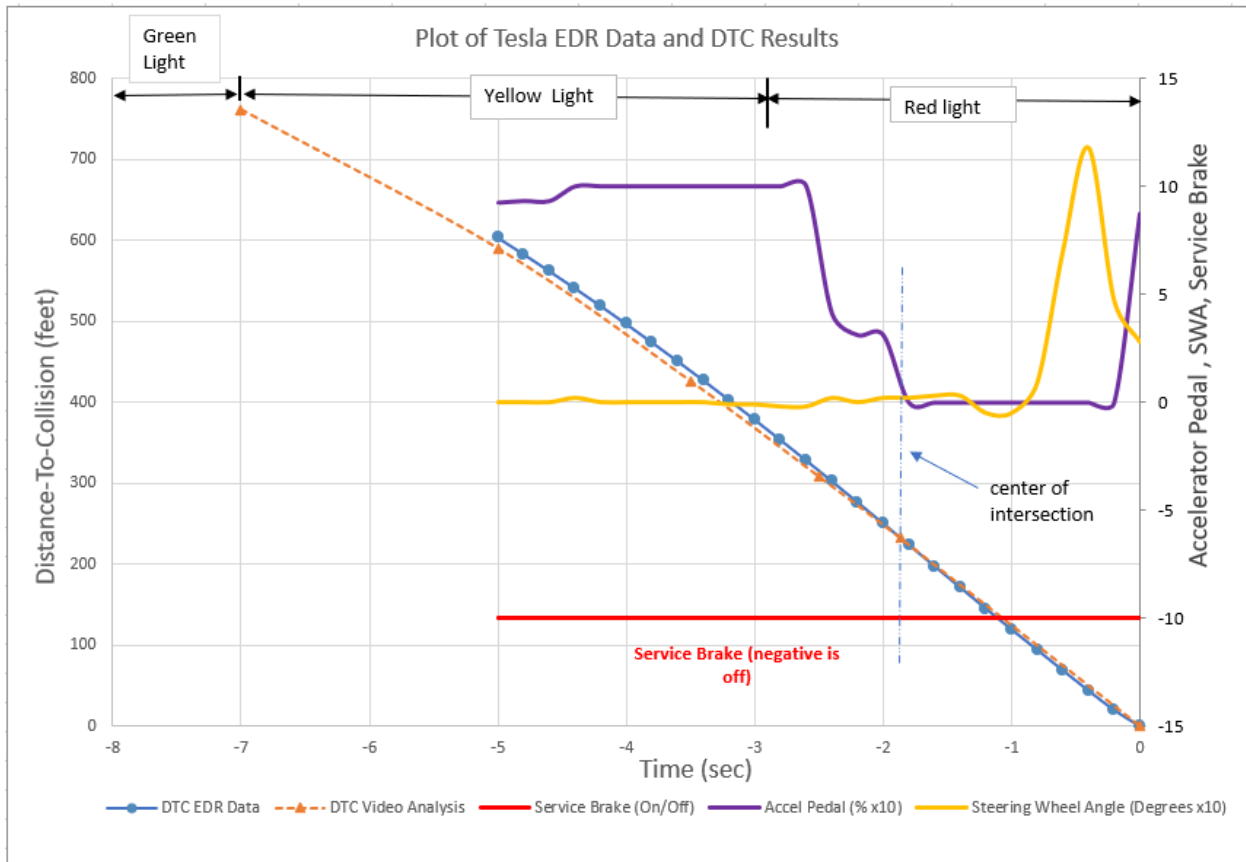


Figure 3. Plot of the estimates of the Distance-To-Collision for the video analysis overlaid with EDR data and traffic light status. Time zero is the collision between the Tesla and the second (final) tree. Negative time indicates time before the collision.

Data used to evaluate the overall consistency of the video measurements with the EDR speeds are shown in Figure 4. As indicated by the data shown in the figure, the measurements from the video analysis are consistent with the Tesla traveling at speeds within about -1 to -4 mph of the speeds indicated by the EDR. The estimated average speed of the Tesla in the video over the last 5 seconds prior to the collision with the second tree was about 80.0 mph. This speed is more than twice the posted speed limit of 30 mph and close to the average speed estimated from the EDR data over the same time period, which is 82.0 mph.

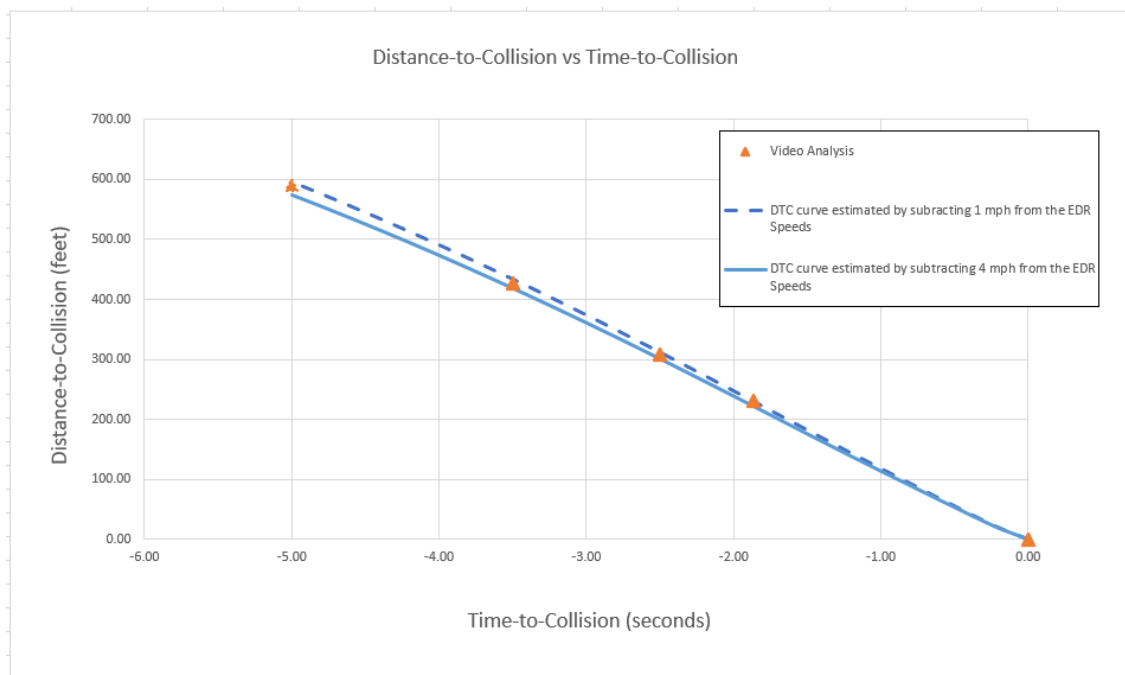


Figure 4. Data used to verify consistency of video measurements with EDR speed data.

Signal Timing at the Intersection of Alhambra Circle with Coral Way

Traffic light signal changes observed in the video at the intersection of Alhambra Circle with Coral Way are documented in Table 1. These results were estimated by stepping through the video to identify when the light changes occurred and using the frame rate to estimate the TTC. Signal light changes documented in the table occurred when the Tesla was south of the intersection of Alhambra Circle with Coral Way in the video. The status of the traffic signals is plotted on Figure 3 along with the EDR data and the results of the video analysis.

Table 1

	TTC (seconds)	Frame Number
Traffic light changes from green to yellow	-7.0 ± 0.03	14451
Traffic light changes from yellow to red	-2.9 ± 0.03	14205

E. SUMMARY

The goals of this study were to estimate the speed of the Tesla in the video, and to document the traffic light changes that occurred in the video in the seconds prior to the collision.

The estimated average speed of the Tesla in the video over the last 5 seconds prior to the collision with the second tree was about 80.0 mph. This speed is more than twice the posted speed limit of 30 mph and close to the average speed estimated from the EDR data over the same time period, which is 82.0 mph. The results of the video analysis indicate that the Tesla was traveling within -1 to -4 mph of the speeds indicated by the EDR data.

The results of the study indicate the following signal light changes occurred in the video:

- At 7.0 ± 0.03 seconds prior to the collision of the Tesla with the second tree, the traffic light signal at the intersection of Alhambra Circle and Coral Way changed from green to yellow. The Tesla was estimated to be approximately 500 feet south of the intersection at that time.
- At 2.9 ± 0.03 seconds prior to the collision of the Tesla with the second tree, the traffic light signal at the intersection of Alhambra Circle and Coral Way changed from yellow to red. The Tesla was estimated to be approximately 110 feet south of the intersection at that time.

Data from the EDR and the video indicate that pressure on the accelerator pedal was released after the traffic signal changed to red. The EDR data also indicate that the service brakes were not applied in the collision sequence.